THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XXII.—No. 552.

THE ELECTRIC LIGHTING ACT.

ELECTRIC light contractors may now fairly pluck up heart of grace. If what they have been saying for so many years be true, by far the greatest of their difficulties is removed. We shall soon see how they adapt themselves to the altered conditions, and the spectacle will be one of absorbing interest. The amendment of the Act of 1882 to which Lords and Commons have assented may not be all that those who have so long agitated for it desired, but it goes a great way to lessen the restrictions which have made public electric lighting upon a large scale almost a commercial impossibility. The period which must elapse before the local authority can acquire an undertaking compulsorily is nearly doubled, and the conditions under which they may acquire are vastly different from what they were in the original Act; for, although express mention of the term "goodwill" is carefully avoided, an equivalent consideration is involved in the fact that the undertaking is to be regarded for purposes of purchase as a "going concern." Now, when a "going concern" is purchased it is an essential element of the bargain that some account shall be taken of the profits arising and likely to arise from it. If electric light undertakers get fair consideration for probable profits they are not likely to lament much the absence of a specific claim for goodwill. It is scarcely conceivable that many lighting stations will remain in operation for a period of 40 years without having paid good dividends. Under a shorter term it might have been said that the difficulties and expense of creating an industry and a demand had absorbed the greater part of the profits, and that what dividends, if any, had been paid were not fair grounds upon which to base a calculation as to anticipated profits. But, although we have been consistently opposed to the principle of compulsory purchase altogether, seeing that it is inevitable, we must confess that forty years of unharassed operation seems to us a fair period to give. We shall probably have something more to say upon this subject shortly, when the changed circumstances of the electric lighting industry have become a little more familiar.

THE SCHANSCHIEFF BATTERY.

THE Schanschieff battery has had, and is having, some rather peculiar experiences. In the first place, it was taken up by a syndicate, which proceeded to dispose of the patent rights for various countries at an immense advantage to itself. The English patents were taken over by a company, the Schanschieff Electric Light and Power Company. Having made some good bargains the syndicate passed into voluntary liquidation. An awkward obstacle, however, soon presented itself to bar the fair progresss of the company: the patents were attacked, first, on an allegation that they were infringements, and then that they were invalid for want of novelty. As there seemed no reasonable probability that this difficulty could be smoothed out without recourse to legal proceedings, the directors of the company repented of their bargain, and tried to procure its recision. Singularly enough, they found the vendors willing to oblige them and to take back the patents. There was no need to return the purchase money, for it had not been paid over. The position is complicated somewhat by the fact that the syndicate was almost non-existent by reason of its liquidation. It was not a very numerous body, however, and there was not much trouble in finding its component members. These took upon themselves to answer for the syndicate and to procure its resuscitation. To do this, we imagine, the consent of the Court will be necessary, but when good cause is shown the Court is not likely to be obdurate. Recalled to life, the syndicate will, we understand, raise further capital to the extent of £10,000 for the purpose of itself conducting the business. This £10,000 will be raised by the issue of ordinary shares of equal value with those at present held by the members of the syndicate. Towards this new capital the shareholders of the company, which will now in its turn go into liquidation, will have a preferential opportunity of contributing. This arrangement seems to have been conducted in a very straightforward and simple manner, and we hope everybody is satisfied. The syndicate has resumed responsibility with perfect willingness, and the shareholders of the company will in all probability get the whole of their money back. Things being as they are, the syndicate will not, perhaps, be above taking a few words of well-meant advice. In the first place we would suggest to it the advisability of adding to its directorate a competent and disinterested electrician, who shall be actuated neither by the sanguine faith of the inventor, nor by the doubting fears of the unskilled, even if able, business man. The valuable assistance which such a functionary could render must be obvious. In addition to this, although as a matter of fact it would necessarily follow upon the adoption of our first suggestion, we would advise the syndicate not to be too ambitious with regard to its commodity. The Schanschieff battery has a clearly defined and a moderately large field wherein its operations may be conducted with success. Its inventor, at any rate, has never made pretensions on its behalf to powers and capabilities which it does not possess. It is essentially a portable battery, and in that capacity is likely to prove of extreme usefulness. It will be exceedingly unwise if its promoters endeavour to apply it to work for which it is not fitted, for to fall short of the full measure of success in any branch of application will be to do their battery business an irreparable injury.

WE are pleased to see that the Corporation of Folkestone has at last decided to adopt the electric light. There can be no question that this is a step in the right direction and that it will be an immense attraction to the town. There is no place on the south coast where electricity could be employed with such an effect as on the magnificent promenade known as the "Lees." The pier company will now probably avail itself of the advantage secured to the town and adopt the electric light in preference to gas. There ought to be no time lost in making the necessary arrangements for the installation so that we may have the full benefit of this improvement for the ensuing season.

THE enactment of the subway law in New York has, it would appear, led to anything but happy results. Nor is it very surprising that this should be the case, considering that at any moment the whole of the property comprised in overhead lines may be rendered valueless to the companies who have expended large sums in the construction of systems authorised by the public functionaries. The immediate consequences of the recent legislation on electric lighting, telegraph, and telephone wires, seem to have resulted in careless and very temporary work being executed, the various companies expending the least possible pains or money in repairs and construction. The business of transforming such an immense system of overhead wiring as exists in New York, is certainly a matter not to be lightly undertaken, and it would appear that a good deal of dissatisfaction is expressed that the question of legislation on such an important undertaking should not have been placed in hands duly qualified, and possessing sufficient knowledge of the subject. In connection with this matter it is worthy of notice that in America the opinion seems still to hold, that no durable first class insulating material has yet been devised.

THE question of dead wires, we are glad to see, is receiving some attention in the States, for, as an exchange says, the dead wires were fast becoming too deadly. A systematic and thorough overhauling of circuits is being carried out in Boston and at Troy, N.Y., and all superfluous and dangerous conductors are being removed.

AN electric lineman sent the following communication to the coroner in New York who was investigating the cause of the death of a lineman who was killed while in the discharge of his duties :—"All electric companies, since the passage of the subway law, have been doing slipshod, temporary work. There are no pains taken with any of the work in either telephone, telegraph, or electric light, and the number of dead, crossed, and broken wires is consequently on the increase." And this the New York *Electrical Engineer* admits to be the unvarnished truth. It is sad to think it is so. Our contemporary, however, while admitting the fact, seems inclined to place the responsibility with the public authorities, by whose permission the structures of the electric light companies were erected, and by whose subsequent legislation the property has practically been confiscated. It would be singular, it says, if under these circumstances the electric companies should feel disposed to spend any more money than they can help in repairing and improving property which may be rendered worthless to them at a day's notice. Singular or not, it seems to us that where an undoubted danger to public safety exists, as in this case, the right course is to remove it, let who will suffer in the pecuniary sense. We are in agreement, however, with our contemporary when it condemns "hasty and ill-considered legislation in response to so-called 'public opinion,' manufactured by interested parties having private axes to grind, and expounded by an untrammelled press, the conservator of our liberties, at the reasonable rate of one dollar per line." The note concludes :—"But the audience may as well keep their seats ; the farce is not nearly over yet." The *Electrical Engineer* seems more keenly alive to the farcical side of the matter than to the tragic.

WE commend to the notice of our readers the results which we publish this week, obtained from an improved type of primary battery. We candidly confess that when we undertook to verify or discount the inventor's assertions, we did not quite expect to be able to corroborate his claims, and it is therefore with all the greater pleasure that we call attention to what we believe constitutes a real advance in the combination of galvanic elements. M. Weymersch has been for some years assiduously at work in perfecting his ideas and he seems to have achieved considerable success. What is still more extraordinary, we have in the inventor a man who really understands the mysteries of primary batteries, who is conversant with the labours of former investigators, and who actually knows the difference between free potential and the working electromotive force at the terminals.

WE have received information that a breakdown again occurred on Sunday week at the Grosvenor Gallery, in this instance entirely uninfluenced by the "inner man" of the epicurean stokers. It is also said that the same thing occurred either on the previous day or on that following, and that a certain noble lord who had expressed his intention of using the electric light in his mansion, has now no further desire to become more closely acquainted with the vagaries of transformer-fed lamps. The Grosvenor Gallery installation has much to answer for, which will be more clearly perceived as time goes on and electric lighting companies endeavour to start new stations.

AN enterprising electrical contemporary, in which one generally looks for accurate news, recently published a list of the electrical tramways in the United Kingdom. Amongst others was mentioned one not a hundred miles from town, and an American gentleman, well known in electrical circles on the other side, took a trip to the vicinity last week with the view of inspecting the above-mentioned line. Much to his disgust, he discovered that it had never been more than purely experimental, and that the trial trips had been abandoned for months. He, however, informs us that he sought solace on Brighton beach, and experienced the pleasureable sensation of traversing, at a speed which almost took away his breath, the length of Mr. Volk's little line. This is only another instance of what we said a few weeks ago, when we ventured to state that the ways of editors were as inscrutable as those of Providence.

IN this country the efficiency of dynamos is always a very grave consideration when one is about to make a purchase, and, although the term is used more frequently than otherwise in a wrong sense, it forms a most, if not the most, important factor when striking a bargain; and if A can show clearly that his machine will deliver 91½ per cent. of the total output into the external circuit, B with only 91 per cent. stands no chance. It may happen, however, and such cases are not rare, that A's brilliant dynamo is frequently in need of either electrical or mechanical repairs, whereas that of B goes plodding along for year after year with but little attention, so solidly is it built. The question is now: Which is the most efficient machine from the user's point of view—the one which demands a few lumps of coal more per day to produce a given result or that which costs £10 or £15 in 12 months for repairs? The answer is obvious.

MR. JOHN THOMAS BROWNE, C.E., of Paris and Madrid, is a curious man. He informs us that any independent expression of opinion based upon a full and complete acquaintance with the "Water Primary Battery" and the "Cabinet Battery" would have value and be duly appreciated, not only by the inventor but by capitalists who have purchased the patent rights. With this view we are in complete accord, always assuming that the person giving an opinion understands his subject; but the value of Mr. Browne's ideas may easily be gauged when we state that he gravely assures us that the present means of generating electric currents mechanically must make way to a continuous and more reliable generator, and that he considers the Water Primary Battery an important step in the right direction. Shade of Maiche! Things are coming to a pretty pass.

HARWICH is a town to which electric light contractors might find it worth while to turn their attention. There is dissatisfaction there with gas, and recently there was something closely approaching a rupture in the relations between the corporation and the gas company. The latter wanted £3 10s. per lamp per annum, and the corporation held out for £2 10s., showing its determination by entering into negotiations for lighting the town with oil; this course had the desired effect, and the gas company reduced its charge by £1 per lamp. The *East Anglian Times* says some of the smaller towns would be admirable places for trying electricity, inasmuch as they are very compact, and the price of gas in them is extremely high; we quite agree.

OUR readers will be interested to learn that "the Council of the British Association of Medical Electricians have appointed Mr. C. B. Harness, consulting medical electrician, President of the Association." This fact appeared in the news portions of several daily papers on Thursday; it had appeared as an advertisement some weeks before.

WHAT is Mr. Woodley thinking of when he tells the people of Ilfracombe that he has "lit several large places in London and elsewhere, and has competed in price with gas companies with gas at 2s. per 1,000 feet?" If he means that he can light a house or a district with electricity in a manner that will satisfy modern demands at a cheaper rate than gas companies can do the same work with their commodity at 2s. per 1,000 feet—well, we can only say we should like to see him do it. There is no reason, for all that, why Ilfracombe should not have its electric light.

THE *English Mechanic*, alluding to our announcement a fortnight ago that a scheme is being set on foot "for the purpose of thoroughly exposing the shams connected with the sale of so-called electro-medical appliances," says:—"That is good news, and it would be interesting if it were followed by the announcement that the sham electricians and electric light promoters were about to be exposed—by the electrical papers." Now, that is a little unkind. The implication of that sentence is that the electrical papers, if they don't precisely support sham electricians and electric light promoters, at least tolerate them by remaining silent and refraining from exposing them. We really thought we had in our time done not a little to expose "sham electricians and electric light promoters," and it is a grievous disappointment to find that a contemporary whose objects are so nearly allied to our own is apparently in ignorance of the fact.

ONE sentence in Dr. B. W. Richardson's article in the *Asclepiad* respecting execution by electricity has a strongly Irish flavour. He says the current may in some cases fail of the fatal effect, and leave the victim in a cataleptic condition. To avoid the possible horror of burying a man alive, he says it will be necessary to conduct a *post mortem* examination! A *post mortem* examination of a live subject is good. But how would the doctor conduct his examination? If in the usual way when it is required to ascertain the cause of death, by opening the body, it would be quite possible to kill a man while trying to find out whether or not he was dead. Unfortunately for those who may happen to come accidentally into contact with the conductors attached to certain systems, there is not likely to be much doubt as to the result. The main thing in applying electricity to the execution of criminals is to see that the current is of much more than merely sufficient strength, so as to allow for exceptional cases and thick skulls.

AFTER all that was said in the American papers about the fatalities from contact with electric light wires recently, it is gratifying to learn from so excellent an authority as Mayor Hewitt, of New York, who has been making a special investigation into the safety of arc lighting, that although no fewer than 7,000 arc lights are now in use in the city of New York, the number of deaths recorded since their introduction nearly ten years ago is only four, and that in two of the cases the unfortunate victims were linemen. This leaves two accidents to members of the public, and one of these is accounted for by the fact that the man deliberately played with an arc lamp. The Mayor's sensible conclusion is that "so small a proportion of accidents is almost unworthy of notice." He further expresses the shrewd opinion that some people have greatly magnified the danger for reasons of their own.

THE TESLA ALTERNATING CURRENT MOTOR.

THE following correspondence has appeared in the *Electrical Review* of New York, upon a subject which is now of very general interest. Dr. Louis Duncan, of Johns Hopkins University, first wrote:

"The Tesla alternating current electromotor has attracted so much notice in the last week or so—a paper describing it having been read before the Boston Society of Arts, another before the American Institute of Electrical Engineers, and a description in the *Electrical Review*—that one is naturally led to enquire as to its possible advantages. The description published in this journal is the only one I have seen, and if one is to accept literally the statement contained in it, the Tesla motor has an unprecedented field of usefulness.

"We may, for our present purposes, divide motors into two classes: Continuous, in which the armature coils are unsymmetrical with respect to the poles, and which, therefore, give a practically constant torque, and alternating motors, in which the armature coils are symmetrical with respect to the poles, and which, therefore, give a torque varying both in magnitude and sign during a period of the counter E.M.F. The Tesla motor belongs to this latter class.

"In every motor the torque is equal to the rate of change of lines of induction through the armature circuit for a small angular displacement, multiplied by the armature current, or

$$\frac{d\,m}{d\,t}\ \text{I}.$$

In the Tesla motor the first of these terms is greatest when the coil is opposite a pole, and the field currents have their greatest amplitude; it is zero at a point about 45° from this, supposing we neglect armature reactions. It depends on several things; the E.M.F. which determines it is due to changes in the number of lines of force passing through the armature circuit caused by (1) changes in the field currents; (2) the motion of the armature. The current depends on these E.M.Fs., and on the reduced self-induction and resistance of its circuit. The motor can only do work when the first cause of E.M.F. is the greater, for a current in the direction of the ordinary counter E.M.F. would stop the motion. In some parts of a revolution the two E.M.Fs. work together, retarding the motion; in others, the induced E.M.F. produces a current causing the motor to revolve. It is impossible for me, with only a meagre description of the principles of the machine to give an idea of the relative magnitudes of these effects. Some of the results, however, are the following: Having given a definite number of reversals of the dynamo, there are a number of speeds, multiples of these reversals, at which the motor will govern itself when it is doing a certain amount of work. At one of these speeds, depending on the construction of the motor, the output will be a maximum.

"Now I see the statement that 'there is no difficulty whatever attendant upon starting the motor under load.' I cannot reconcile this with above facts. That the torque for a smaller number of revolutions than ordinarily used might be greater one can readily see, since the counter E.M.F. is less in proportion to the induced E.M.F., but it must be remembered that for certain speeds even the induced current would tend to stop the motion; how the motor is to pass these critical speeds I do not see. Again, if the maximum load is suddenly thrown on while the motor is running at its proper speed. Then, if the inertia be great, the motor will fall behind its point of maximum work and either stop or take up some slower speed.

"What the possible efficiency and output of the motor may be only experiment can tell. I have shown* that the output of an ordinary alternating motor is equal to that of a continuous current motor supplied with a corresponding E.M.F. The efficiency might be great, but it has the disadvantage that about the same current flows for no work and maximum work, so for light loads the efficiency can hardly be very high.

"With our present knowledge of alternating currents it is useless to attempt to calculate from the simple, though misleading, assumptions ordinarily made, the output, conditions of maximum work, &c., of this machine. Experiment alone can determine its value, and one properly conducted and interpreted set of experiments should enable us to judge both the merit of the invention and its best possible form. I cannot see, however, how, in the form described in the last issue of this journal, the motor can work under conditions of a suddenly varying load as satisfactorily as continuous current motors."

To this the inventor, Mr. Nikola Tesla, replied:—

"I find in your issue of last week a note of Mr. Duncan referring to my system of alternate current motors.

"As I see that Dr. Duncan has not as yet been made acquainted with the real character of my invention, I cannot consider his article in the light of a serious criticism, and would think it unnecessary to respond; but desiring to express my consideration for him and the importance which I attach to his opinion, I will point out here briefly the characteristic features of my invention, inasmuch as they have a direct bearing on the article above referred to.

"The principle of action of my motor will be well understood from the following:—

"By passing alternate currents in proper manner through independent energising circuits in the motor, a progressive shifting or rotation of the poles of the same is effected. This shifting is more or less continuous according to the construction of the motor and the character and relative phase of the currents employed, and I have indicated the theoretical conditions which should exist in order to secure the most perfect action.

"If a laminated ring be wound with four coils, and the same be connected in proper order to two independent circuits of an alternate current generator adapted for this purpose, the passage of the currents through the coils produces theoretically a rotation of the poles of the ring, and in actual practice in a series of experiments, I have demonstrated the complete analogy between such a ring and a revolving magnet. From the application of this principle to the operation of motors, two forms of motor of a character widely differing have resulted, one designed for constant and the other for variable load. The misunderstanding of Dr. Duncan is due to the fact that the prominent features of each of these two forms have not been specifically stated. In illustration of a representative of the second class, I refer to fig. 1, on page 1 of *Electrical Review* of May 12th. In this instance, the armature of the motor is provided with two coils at right angles. As it may be believed that a symmetrical arrangement of the coils with respect to the poles is required, I will assume that the armature is provided with a great number of diametrically wound coils or conductors closed upon themselves, and forming as many independent circuits. Let it now be supposed that the ring is permanently magnetised so as to show two poles (N and S) at two points diametrically opposite, and that it is rotated by mechanical power. The armature being stationary, the rotation of the ring magnet will set up currents in the closed armature coils. These currents will be most intense at or near the points of the greatest density of the force, and they will produce poles upon the armature core at right angles to those of the ring. Of course, there will be other elements entering into action which will tend to modify this, but for the present they may be left unconsidered. As far as the location of the poles upon the armature core is concerned, the currents generated in the armature coils will always act in the same manner, and will maintain continuously the poles of the core in the same position, with respect to those of the ring in any position of the latter, and independently of the speed. From the

* Inst. Elec. Engineers, February, 1888.

attraction between the core and the ring, a continuous rotary effort, constant in all positions, will result, the same as in a continuous current motor with a great number of armature coils. If the armature be allowed to turn, it will revolve in the direction of rotation of the ring magnet, the induced current diminishing as the speed increases, until upon the armature reaching very nearly the speed of the magnet, just enough current will flow through the coils to keep up the rotation. If, instead of rotating the ring by mechanical power the poles of the same are shifted by the action of the alternate currents in the two circuits, the same results are obtained.

"Now compare this system with a continuous current system. In the latter we have alternate currents in the generator and motor coils, and intervening devices for commutating the currents, which on the motor besides effect automatically a progressive shifting or rotation of the poles of the armature; here we have the same elements and identically the same operation, but without the commutating devices. In view of the fact that these devices are entirely unessential to the operation, such alternate current system will—at least in many respects—show a complete similarity with a continuous current system, and the motor will act precisely like a continuous current motor. If the load is augmented the speed is diminished and the rotary effort correspondingly increased, as more current is made to pass through the energising circuits; load being taken off the speed increases and the current, and consequently the effort, is lessened. The effort, of course, is greatest when the armature is in the state of rest.

"But since the analogy is complete, how about the maximum efficiency and current passing through the circuits when the motor is running without any load, one will naturally enquire? It must be remembered that we have to deal with alternate currents. In this form the motor simply represents a transformer in which currents are induced by a dynamic action instead of by reversals, and as it might be expected the efficiency will be maximum at full load. As regards the current, there will be—at least under proper conditions—as wide a variation in its strength as in a transformer, and by observing proper rules, it may be reduced to any desired quantity. Moveover, the current passing through the motor when running free, is no measure of the energy absorbed since the instruments indicate only the numerical sum of the direct and induced electromotive forces and currents instead of showing their difference.

"Regarding the other class of these motors, designed for constant speed, the objections of Dr. Duncan are, in a measure, applicable to certain constructions, but it should be considered that such motors are not expected to run without any, or with a very light load, and, if so, they do not, when properly constructed, present in this respect any more disadvantage than transformers under similar conditions. Besides, both features, rotary effort and tendency to constant speed, may be combined in a motor, and any desired preponderance may be given to either one, and in this manner a motor may be obtained possessing any desired character and capable of satisfying any possible demand in practice.

"In conclusion, I will remark, with all respect to Dr. Duncan, that the advantages claimed for my system are not mere assumptions, but results actually obtained, and that for this purpose experiments have been conducted through a long period, and with an assiduity such as only a deep interest in the invention could inspire; nevertheless, although my motor is the fruit of long labour and careful investigation, I do not wish to claim any other merit beyond that of having invented, and I leave it to men more competent than myself to determine the true laws of the principle and the best mode of its application. What the result of these investigations will be the future will tell; but whatever they may be and to whatever this principle may lead, I shall be sufficiently recompensed if later it will be admitted that I have contributed a share, however small, to the advancement of science."

PRACTICAL NOTES CONCERNING THE CONSTRUCTION, USE AND MANAGEMENT OF STORAGE BATTERIES.

By A. RECKENZAUN.

(*Continued from Vol. XXII., page* 7.)

Effect of density of sulphuric acid on the E.M.F. and difference of potential.

WHILST the E.M.F. of a lead and peroxide of lead couple is only about two volts, under normal conditions, it has been found that the same reaches as high as 2·25 volts with a newly charged cell, but this extra quarter volt vanishes almost instantly. We have shown that the specific gravity of the acid rises evenly with the amount of charge put into an acccumulator (*vide* fig. 4) or withdrawn therefrom. By means of fig. 6 it was demonstrated graphically that the charging E.M.F., when the current is kept constant, does not vary in exact proportion to the energy stored up, consequently the E.M.F. of a secondary battery does not seem to rise and fall with the s.g. of the electrolyte.

In a letter to the ELECTRICAL REVIEW, Sir David Salomons stated that, "as the s.g. of the liquid rises, whether by charging or by strengthening the solution by the addition of acid, the E.M.F. becomes higher and higher till the limit is reached." Since this statement has not been contradicted, it would appear that many electricians share these views. Increasing the density of the electrolyte, up to a certain degree, can only have the effect of reducing the internal resistance of the cell, and this would augment the *potential difference* slightly, but it does not raise the E.M.F. of the battery in the same ratio. Practically there is no difference in the E.M.F. of cells containing acids of different densisities, provided they have all been charged alike and tested simultaneously. But the capacity and the constancy of a lead battery is materially influenced by the strength of the sulphuric acid it contains. Naturally, the action of a cell would cease as soon as the electrolyte is reduced to pure water, no matter what the amount of charge may have been originally, therefore it is necessary to arrange the density and volume of acid according to the quantity of lead to be acted upon.

Chemical changes influenced by strength of acid..

Messrs. Gladstone and Tribe have made experiments to determine the amount of oxygen fixed by the positive electrodes with varying strengths of acids, using plates of about 12 square inches of surface which were charged by a current of about one ampère. It appeared from those experiments that strong sulphuric acid is not quite so favourable to the action as the more dilute (1 to 10), but that between this proportion and 1 to 500 there is no great difference in the amount of oxygen fixed, and therefore of corrosion of the plate. With sulphuric acid diluted with 1,000 parts of water, the amount of oxygen fixed, and therefore of corrosion, was at least doubled, while the chemical action was very different. On parts of the electrode, streaks of a mixture apparently of the yellow and puce-coloured oxides were seen. On other parts a white substance formed and was easily detached, falling in clouds into the liquid. This white substance gave an analysis SO_4, equivalent to 73·6 per cent. of lead sulpbate, suggesting the idea that it was a basic sulphate of the composition 2 $PbSO_4$, PbO, which would require 73·1 per cent. As the peroxidation of the lead is required, and the corrosion of the plate is to be avoided as much as possible, it is evident that this extremelyidilute acid must be avoided; and it has been shown that if the sulphuric acid is entirely removed from solution, as sometimes may happen in an accumulator, the lead is simply converted into hydrated protoxide, and therefore corroded without any good effect.

Density of acid and resistance.

It appears that very strong and very weak acids have not only a detrimental effect upon the

chemical action, but they do at the same time increase the resistance of the battery; consequently it must be wise to keep the specific gravity within narrow limits, in order to obtain the best results. After numerous experiments we have come to the conclusion that it is advantageous to use acid of such a strength that when a cell is fully charged its s.g. should not exceed 1·200.

TABLE X.

SPECIFIC RESISTANCE OF SOLUTIONS OF SULPHURIC ACID.

Specific gravity.	Percentage by weight of sulphuric acid.	Temperature in centigrade.	Specific resistance. ohms per cubic centimetre.
1·003	·5	16·1°	16·01
1·018	2·2	15·2	5·47
1·053	7·9	13·7	1·884
1·080	12·0	12·8	1·368
1·147	20·8	13·6	·96
1·190	26·4	13·0	·871
1·215	29·6	12·3	·83
1·225	30·9	13·6	·862
1·252	34·3	13·5	·874
1·277	37·3	...	·93
1·348	45·4	17·9	·973
1·393	50·5	14·5	1·086
1·493	60·6	13·8	1·549
1·638	73·7	14·3	2·786
1·726	81·2	16·3	4·337
1·827	92·7	14·3	5·32

According to Mathiessen (Table X.), acid of 1·215 degrees has about the lowest specific resistance ; above and below that it rises gradually. It should, however, be noted that the total volume of acid must bear a certain proportion to the volume of active material, and on this we commented in one of the earliest paragraphs. By using a maximum s.g. of 1·200 we approach the lowest resistance, and whilst allowing the volume of acid to be greater than the volume of plates, the s.g. never falls to a dangerous degree, provided the cells are not allowed to stand idle for any length of time when quite or nearly discharged.

Effect of temperature upon the E.M.F. of a battery.

Beetz and Robinson have independently investigated the effect of heat upon the E.M.F. of cells, and they have found that the same diminishes with every rise above the ordinary temperature. Beetz showed that the E.M.F. was 2·216 volts at 20° C., and as the temperature was raised it fell off, slowly at first, more rapidly afterwards, till at the boiling point it was only 1·904 volts. Bartoldi examined the E.M.F. of polarisation in a cell containing sulphuric acid with platinum electrodes, and found it to be twice as great when the liquid was at 5° C. as when raised to its boiling point. Secondary batteries should therefore be kept cool.

An attempt was made to *freeze* a battery during the severe winter of 1888 in Philadelphia, one cell being exposed in the open air for 24 hours at the temperature of zero Fahrenheit ; this merely raised the s.g. of the acid by a few degrees ; the E.M.F. kept practically constant ; the cell was fully charged, and its acid at 1,185. Another unsuccessful attempt was made in New York to freeze the electrolyte of a cell at 10° F. below zero. During the blizzard of last March on the Canadian frontier it was reported that several cells which were suspended under the floor of a railway carriage had their acid frozen. The cells were completely discharged after supplying current for lighting the train during a protracted journey, when the temperature was about 20° F. below zero.

(*To be continued.*)

New Submarine Cable.—On the 27th of this month at the Central Telegraph Office in Madrid, public adjudication will be made of a contract for the manufacture and laying of a submarine cable between Savea, a small town on the coast of the province of Alicante, and Ibiza, one of the Balearic islands.

INSTALLATION BREAKDOWNS.*

By REGINALD J. JONES, A.S.T.E.

IT has been aptly said we learn more from our failures than our successes. In no branch of science does this apply more truly than to that of electrical engineering. A breakdown is, perhaps, the best practical test of the efficiency of the *man* part of an installation.

Speaking very generally of breakdowns, they may be divided into four great classes :—

1. The motive power.
2. The electrical generating and storing plant.
3. The conductors.
4. The lamps and fittings connected therewith.

With regard to the first, it is outside the object of my paper to go into details of accidents in connection with steam or gas engines, turbines, &c. ; but in passing it may be stated practice seems to point out that the best results as far as continuity of supply of current, for whatever purpose it may be required, is obtained by using several engines and dynamos instead of one large one, for with the latter condition it is simply a question of time before you have a breakdown. From an economic point of view it would seem, too, that the former is the best arrangement, as friction is proportionate to the load.

The following points are essential in connection with the management of long-running engines, shafting, &c. :—

1. Examine every bolt and nut, such as on eccentric straps, &c., before starting. Do not trust to luck.
2. Tap all cast-iron fly-wheels, riggers, &c., to see if they are cracked.
3. If there are joints in bands or splices, examine carefully before starting.
4. Have electrical heat alarms on the main bearings.
5. Clean and tighten all electric connections.
6. Provide a water supply over the main journals in case of need.

Prof. Thomson, in his admirable paper on "Diseases of Dynamos," pointed out the most probable sources of failure in these machines. From actual experience, it will now be my endeavour to tell you a few acute cases, with their symptoms, causes, and cures.

ARC DYNAMOS.

Firstly, we will consider some cases of arc light dynamos failing to work, owing to faults (first) in the armatures, (secondly) in the fields, (thirdly) the connections, and (fourthly) the driving gear.

The machine we will consider first is a 16-light arc Brush machine. A short time after starting sparks were noticed on the outside of the armature coils when they passed the pole-piece, where the coil is cut out. These in a very few minutes became so big that the dynamo had to be stopped. On examination, the insulation between some of the wires on a coil was found to have been scraped away, and a small arc was formed. The spark only occurred when the coil was cut out of circuit, the extra current causing it then to jump the air-space. The cure was effected by blocking the wires apart and putting some tape, soaked in shellac varnish, to insulate them.

Another breakdown of a Brush armature may be here mentioned. A 16-light dynamo, on being started with the circuit open, instead of showing very small sparks, kept up a continual flashing round the commutator : the cause of this was the breaking down of insulation between the wires of the armature coils in the bundle, thereby causing a circuit through some of these armature coils—this generally necessitates a new set of wires connecting the coil and commutator.

Connections.—In some large engineering works a Brush dynamo had been running the lamps on the previous night well ; but towards the end of the run some smoke was seen to come from under the wooden base, on which the copper springs, which connect the

* Paper read before the Old Students' Association, at the Finsbury Technical College, on May 29th.

brushes to the outside circuit terminals and fields, are mounted. As is very often the case with non-electrical persons, the water-cure was tried, but naturally without success; and on the following night the machine would give no current at all. By short-circuiting from the brush to the terminal, so as to cut out the connection below, the dynamo started all right; the cause of the trouble was the nut clamping the brush spring to the wire connection below becoming loose and starting an arc. The arc carried the current all right as long as the machine was working; but on cooling down these metals were further apart, and coated with a poor conducting film having too high a resistance for the machine to build up current through it. A cure was effected by taking off the washer, scraping the dirty surfaces, and securing it in place again. (Fig. 1.)

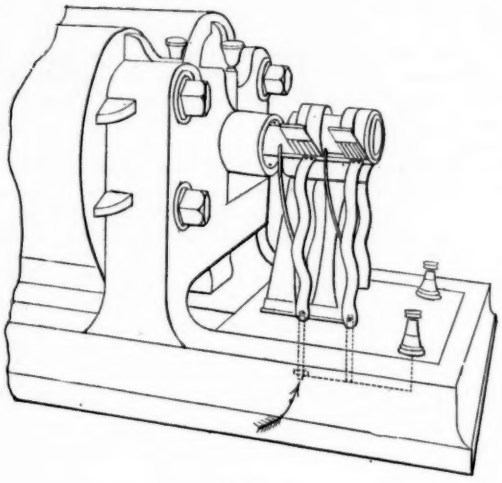


FIG. 1.

Another mishap coming under the head of connections occurred to a Brush dynamo running in a central station. The only symptoms were a sudden flashing over on the commutator, then total extinction of the lights. On stopping the dynamo it was tested with a detector to see if the circuits were intact. No deflection could be got by testing through the terminals of dynamo, but keeping the galvanometer and battery still on, and examining the wires which connect the fields, the needle was found to move when one wire was handled. Ultimately it was discovered that the tin sleeve joining the two wires had been placed considerably more on one than on the other. The solder which had hitherto held the wires in place was melted. Further tests showed a short circuit on the mains: thus, the lead acted as a fuse, and probably saved something more expensive to repair.

Driving.—One rather curious accident happened to an arc light dynamo, which was driven from a countershaft with a very tight short-drive belt. About half an hour after starting the night's work the machine flashed continuously at the commutator, the engine raced, and finally the belt was thrown off the machine. This was replaced, and a second time there was a repetition of the flashing and racing of the engine. On putting treacle on the belt and tightening up slides these troubles disappeared.

The cause was this: A sewn joint had been made in belt in the morning, and a new piece of leather introduced. This suddenly stretching, caused engine to race, dynamo to flash, thereby increasing racing of engine, finally causing belt to slip off dynamo pulley.

Driving Gear.—A fault in the driving gear of an alternating current machine assumed an uncanny bearing by appearing just at 9 o'clock every night. The machine was driven by a gas engine and a leather link belt. To all appearances everything was in its normal condition, the lamps were up to full E.M.F., &c., but just at 9 o'clock the belt began to run to one side of the pulley, and always ended by coming right off. This occurred for many nights in succession. At last we found, by putting some waste on belt as soon as the symptoms of running off occurred, the belt would run all right. At last it was found that the main bearing oil way was stopped, and all the belt surface became coated with oil about two hours after starting, thus causing the belt to lose its grip.

In the maintenance of high tension arc dynamos the following are important points to be observed:—

1. Have the framework of the dynamo thoroughly insulated from earth.
2. Keep your commutator segments and brushes scrupulously clean.
3. Keep the commutators thoroughly wiped during running. Never use articles like sponge cloths to wipe commutator of open segment type. A case once came under my notice where this was done; the public did not think much of the experiment from a lighting point of view, and there were four brushes to straighten.
4. Keep the oil from getting in among the wires leading to commutators.
5. An automatic regulator on the fields reduces the risk of breakdown very much.

ARC LIGHT BREAKDOWNS.

By no means the most secure portion of a high tension system of lighting is that comprised under the heading of circuit. These may be divided into two distinct classes or types, viz., overhead and underground. In the former the chief risks are from leakage, due to stress of weather or flaw in materials used, accidental contacts of other wires, such as telephone, either causing a short circuit or damaging the instrument, and, lastly, liability to atmospheric electrical discharges. In big cities the continuity of supply is frequently endangered by fires breaking out. The advantages may be said to be cheapness of erection, ease of testing, and maintenance.

In the underground system the great danger is the difficulty of maintaining insulation and cost of putting down the system. The advantages of underground systems are the freedom from breakdown in heavy weather and stability, and certainly it must strike every mechanical engineer as being a better job. We will consider first a few cases of overhead breakdowns.

In an arc light circuit in some large engineering works, when the circuit was tested for insulation on a certain day, by bridge measurement it varied from 400,000 ohms to dead earth. The insulation would then remain high for half-an-hour at a time, and again vary intermittently from zero to the maximum. This went on for several days, until it occurred to me to test on a Sunday, when the works were stopped. On this occasion there was a permanent dead earth. After a little cutting of sections the weak spot was traced out, when it was found that a portion of cable had been dragged away from the cleats by a travelling crane, and was rubbing against a fast and loose pulley, the insulation being rubbed right through. When the cable rested on the belt there was good insulation, but when the belt was shifted to the other pulley it rested on the iron and gave dead earth.

In one case of arc lighting from a central station, run on the overhead system, the following occurred. On the previous day, the conductor was about 15 ohms, including lamps. The lamps ran perfectly well until midnight, the usual stopping time. On testing the conductor next day it was found to be 3,000 ohms. The fault could not be discovered by lighting-up time, so we decided at any rate to try what would happen by starting the dynamo, everything lit up as if 3,000 ohms, more or less, were a mere matter of detail. Afterwards, we found it really lay in a quadrant switch, which had become loose, the two contact surfaces were covered with little incrustations caused by the arcing. On the machine building up this spurious resistance disappeared.

In another long circuit of arc lamps, the circuit on

being tested showed a perfect break of continuity, while at the same time the positive end of the cable gave good insulation and the negative a dead earth. There had been a heavy gale during the night, causing a lamp to become unhooked at one terminal only, consequently the chimney touched the iron hood, which was in contact with earth, while the unconnected terminal gave perfect insulation—hence the necessity of snap hooks.

A very curious phenomenon showed itself in connection with a series system of transformers on an alternating high tension system. There was a leakage to earth on the mains somewhere. On placing an incandescent lamp in series to earth in the engine room, the filament was incandesced. As many as 18 lamps could be put in series, all lighting up with a very small difference in illuminating power to the single lamp. It would be of interest to know if others have observed a similar thing. (Figs. 6 and 7.)

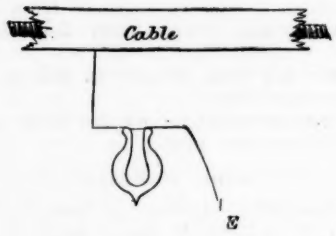


FIG. 6.

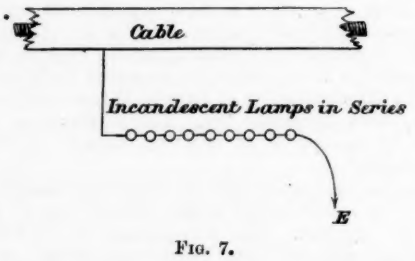


FIG. 7.

In dry climates, such as South Africa, they have to put comb collectors over the brushes of the dynamo, to discharge the atmospheric electricity from the line. In England, too, we occasionally suffer.

During a heavy thunderstorm a breakdown occurred on an arc light system of underground wires. A portion of the lamps on circuit were suddenly put out. The lightning had struck a lamp-post, burnt out coils and lamp cut-out, then broke down the insulation of cable at two places, so that a portion was short-circuited, thus

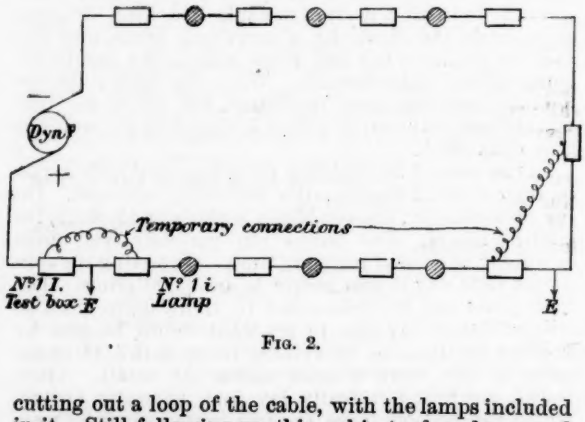


FIG. 2.

cutting out a loop of the cable, with the lamps included in it. Still following up this subject of underground arc circuits, the following is interesting in showing how the faults were eliminated. The symptoms were:—The engine raced and dynamo flashed. On going round circuit a portion of the lamps were found to be out, and it was seen that No. 1 fault lay on the wire before No. 1 lamp. The dynamo was stopped, and circuit broken at No. 1. The dynamo was again started, so that current ran through faults only. We then followed line up by opening street boxes and tested for current with a compass needle, and found fault lay between two boxes. Dynamo was again stopped, and a temporary cable connected through overground (fig. 2).

ARC LAMPS.

The arc lamps themselves are frequent causes of trouble in the circuit. The Americans call this the "specific cussedness" of the lamps; the minor faults are so numerous that they would fill a paper by themselves.

The following, however, is a somewhat curious example of some of the freaks of arc lamps. A set of 40 arcs in a public building had been running very well for three or four months, when suddenly, night after night, lamps in various parts of the circuit would burn very dull red, get duller, and finally go right out. The dynamos were in good order, the current the same, and the insulation perfect of machines and circuits, yet sometimes as many as eight or ten lamps would be out together.

To discover the cause, a lamp was taken down low, and someone put on to watch its behaviour. Then was noticed a sort of bubble of molten liquid collecting on the positive carbon, which trickled down into the arc. The lamp then gave only red glow, the globule gradually cooled and finally short-circuited the carbons. The difficulty was thus solved, for it was then remembered that a fresh batch of carbons had been used since the commencement of the fault. On changing these for good carbons we had no further trouble.

Let us now consider a few points in connection with low-tension systems.

DYNAMOS.

Driving Gear.—A very puzzling, though simple, fault, occurred in a compound dynamo, which had been running extremely well for several months, until one night when it was found that, with the full complement of lamps, only 20 volts could be obtained instead of 80. On running the machine light, the full E.M.F. was shown on the voltmeter. The circuits of the dynamo and those of the installation were tested and found to be in perfect order—the engine and dynamo were running at normal speed. Eventually, on going to take the speed at the commutator end, it was observed that the end of dynamo shaft and commutator were rotating at different speeds. On further investigation it was found that the commutator and armature, which were mounted on a sleeve, were slipping round the shaft, the set screws having slacked away. The load, of course, dragged the armature back, whereas when light it rotated at proper speed.

Connections.—A mistake in coupling up led to a curious result with another compound dynamo—the direction of rotation was changed, and the shunt wires only were crossed. On running the machine light, with the pilot lamp only, the dynamo worked all right; but on putting the whole load on, as the series coil now worked against the shunt, the light may be best described as a minus quantity. We have yet another instance of faulty connections in the case of a new shunt dynamo installed, but all efforts failed to get it to build up. The insulation of the armature and fields was perfect, the field circuit was intact, and to all appearances the armature wires were not broken. There was no sign of sparking at the brushes at any angle, or any speed. The cause of this was that the field connections had been by mistake crossed and connected to the wrong terminals, probably after varnishing. Reversing these caused the dynamo to magnetise without further trouble.

ARMATURES.

We find that the armature is the part of a dynamo most liable to disaster. In series wound or compound

dynamos there is great danger of an excess of current causing fusion or breakage should a short circuit occur. Another fault common to armatures is shown in the following breakdown. A small shunt dynamo, which was used for charging accumulators and driven by a gas engine, exhibited these symptoms; no current could be got through the cells, but the machine would run a few lamps direct. There was, however, continuous sparking at the commutator. On taking adrift a pair of wires on the commutator a break was found (by testing with a galvanometer) in one of the coil wires just where joined to the commutator. One circuit of the armature was always supplying current, and whenever the broken part passed the brushes sparking occurred. On repairing this breakage the machine worked well again. (Fig. 3.) The following, too, is

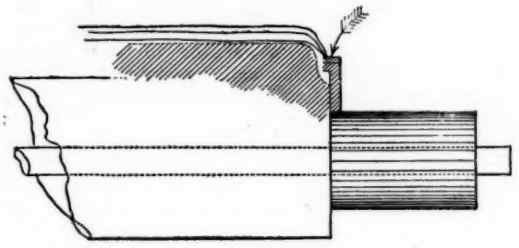


FIG. 3.

an interesting case of the mischief damp causes. Two 300-light plain shunt dynamos were used to run an installation. They were run generally week and week about. After a week's idleness one dynamo refused to build up at all. On testing with a battery and detector the armature was found to be in connection with the shaft, and on further inspection was discovered to be quite damp. Then it was remembered that a pane of glass in the skylight above had been cracked during the week, and through it rain had dripped on to the machine. To restore the insulation a small current was kept on through the armature, the heat set up dried out the moisture, and the machine worked perfectly again.

Fields.—*Apropos* of the extremely bad habit of breaking the circuit of a dynamo by lifting the brushes whilst the machine is running, the following case shows the effect on the constitution of a machine. A four-pole shunt machine had been doing its work perfectly well for some time, until one night it was found impossible to get the full amount of light. The machine was taken to pieces, and a hole was found on one field burnt right through insulation consisting of three layers of calico steeped in paraffin, and the layer of paper and two holes were found on the other pole; thus short-circuiting a pair of limbs of the magnets. The attendant here had been in the habit of breaking the circuit with the machine running at a high speed.

Armature.—A very serious structural weakness of drum armatures is exemplified in the following case, which occurred to a compound machine running incandescent lamps. By some external means the mains were accidentally short-circuited; the main fuse went, but did not go before allowing a considerable rush of current through the armature. This caused the end band binding (made up of fine steel wire) of the armature to burst before the dynamo could be stopped; quite a number of sparks were seen at the pole-pieces, accompanied by a very strong smell of shellac burning. The pilot-lamp over the dynamo, however, burnt properly. On examination of the armature it was found that the sparks were caused by loose steel wire ends striking against the pole-pieces; and the smell of shellac was probably due to heating of the wire by friction, and consequent heating of shellac on armature wires; the latter were quite uninjured.

In connection with the subject of bands breaking a very novel accident occurred to a generator supplying current for a tramcar. The dynamo was a 300-volt shunt machine. The plant had been working well for some hours. On the first part of the journey the tram had to go up a stiff incline, while just before the terminus the incline was in its favour; the current at this point was switched off. The car completed one journey, but on trying to start again the machine would not build up; the circuits and insulation were tested with a galvanometer, and found in perfect order. The fields were then externally magnetised by a hand dynamo, all other means having failed. For a while the dynamo worked all right, but again broke down, exhibiting the same symptoms, except that now the field was broken. After the second stoppage it was found one of the armature-bands had broken, and the broken ends, in rotating, had cut through a field-magnet circuit. This, however, had fused together again, probably by the arc caused by extra current; but how the permanent magnetism of the poles disappeared was never made very clear.

These bands very frequently break. It would be interesting to hear from others what has generally been the cause of this—viz., bad mechanical fastening of ends, insufficient initial strength, fusion through contact with opposite sides of armature, or some such cause as the above first case.

COMMUTATORS.

The next part of the dynamo we will consider as a cause of breakdown is the commutator. As would naturally be supposed, the copper dust cut by the brushes and oil used in wiping the surface of commutator frequently give trouble. As examples of this fault, two cases may be cited—the first of a compound machine which, after running well for some time, began to spark very much, the armature becoming unduly heated. The cause was found to be copper dust and grease getting in behind the leather shield which covers right close up to the commutator, and causing a partial short circuit.

The second case was that of a series-plater, the commutator segments of which have air insulation below and between them. Here, after a while, a little mound of copper dust accumulated under the segments, eventually short-circuiting the commutator on to the steel shaft. To effect a cure the segments were removed and cleared. A second weak point is in the ring which clips the segments together at the end. Cases have come under my notice in which the insulation has broken down, and a short circuit established.

As Professor Perry in his recent lectures has shown us, the mechanical engineer seems sometimes to think that a dynamo being a new departure, old methods may be neglected, and has strangely forgotten or left out precautions which he would in all other high-speed machinery adopt. The following case, bearing upon this point, came under my own notice. The makers of a well known ring armature made their machine so that at the pulley end the inside face of the pulley was made to act as the distance-piece to prevent side play of the armature. The pulley itself was fixed on by a feather, and secured at the end by lock nuts; these while running worked loose. The result was a general firework display and a job for the armature winders, for although an armature puts up with very little clearance at the pole-pieces nowadays, it draws the line at actual contact with the same.

We now pass on to consider incandescent lamps, circuits, fuses, &c.

INCANDESCENT LAMPS.

Unlike arc lamps, the faults of incandescent lamps are not as varied. The principal causes of failure may be stated to be weakness of the glass bulb, which frequently breaks under atmospheric pressure; weakness of a portion of the globe at one point, as specimen exhibited; leakage at the points were platinum wires enter, and bad vacuum resulting therefrom; want of symmetry in diameter of filament, hence heating unduly at one point, causing rupture ultimately; want of

stability of filament, causing it to fall to one side, touching the glass and breaking it; deposition of carbon on the glass, &c. In very bad lamps the sudden expansion of gases has caused the globe to burst outwardly. The glass at point where the platinum enters sometimes cracks, due to imperfect contact and arcing.

Fuses.—No one will dispute the fact that the circuits of an incandescent system may be a source of danger to a building if not properly installed. As it is now a *sine qua non* that all such work be protected from short circuit or leakage with fuses, that danger is reduced to a minimum. It would seem to me that the system most likely to give best results in placing of fuses is one which reduces the number of these to as few as possible, consistent with safety. By this is meant that there should be a double-pole fuse placed at the root of a branch, so that the fuse will go should a current pass, by leakage or short circuit, which would dangerously heat the smallest wire on that branch. In the future it seems likely that double-pole magnetic cut-outs will be more extensively used for this purpose, as this form may be relied upon to go at a given current.

As an instance of the result of improper use of fuses, there is the not uncommon fault of putting in single-pole fuses indiscriminately. This has doubtless been the cause of some trouble, and one case came under my notice where a sub-circuit was burnt right out through this. (Fig. 4.) From a well-authenticated source, the following

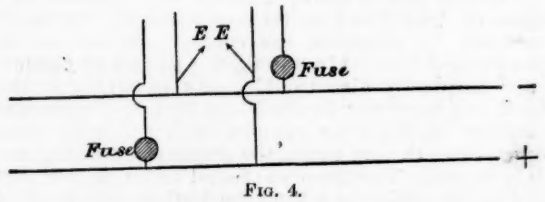


FIG. 4.

very curious case, where combination of gas and electricity were responsible for some damage, has been given me. An ordinary lead wire fuse gave out through excess of current passing, and actually set fire to some gas which was escaping from a pipe close by. One great source of danger in an installation otherwise admirably protected by double-pole fuses arises from the fact that in these double-pole fuses both terminals of the mains are brought close together and bared. It would be far better, in my opinion, if two separate single-pole cut-outs were inserted, one on each main. (Fig. 5.)

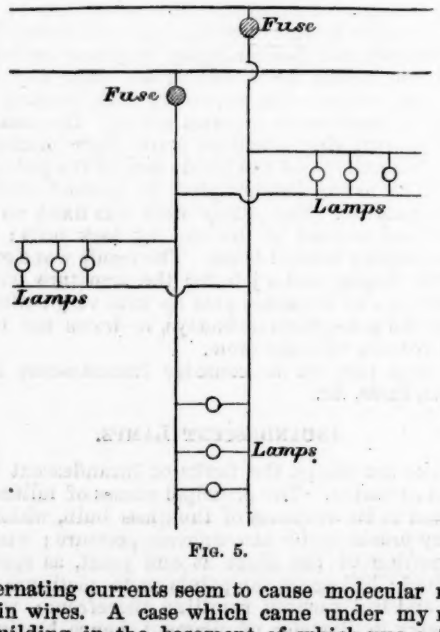


FIG. 5.

Alternating currents seem to cause molecular movement in wires. A case which came under my notice in a building, in the basement of which was a three-light electrolier, the lamps of which all began to flicker very rapidly; the cause was at last traced to the fuse, which was found to be working loose. From my experience of alternating currents, it seems that nuts always tend to work loose. Hence another reason for reducing the number of points of fuses.

It would be of great interest to hear if others have noticed the same phenomena more markedly in alternating circuits than in those of direct currents. As may be generally known, the fuses for the high-tension currents used for transformers are made of copper wire passed through sheets of asbestos, which are inserted to break the arc when the fuse goes. This asbestos seems to have a peculiar corrosive action on the copper wire, for at the points of contact the wire gets green, and soon eats away. *Apropos* of fuses and incandescent circuits, it would be of great value to all to hear of some authenticated cases of a fire arising from a minute leakage, but one not great enough to cause the fuse to go.

Insulation.—In concluding this interesting part of the subject, the following example of breakdown of insulation may serve as a warning to those who take what is sent them without making any tests. A whole floor of a large hotel had been very carefully wired, as far as mains were concerned, with a new cable laid in a wooden casing let in the joists, and on the wiremen completing the work the cable was tested to see if there was any sign of leakage. A very sensitive astatic galvanometer was used with a 200-volt chloride of silver battery. To their dismay, the cable showed a leakage of about 80 degrees—they were absolutely sure it was kept perfectly free from iron or earth contact. To find the fault the whole of the covering was taken up, and the mode of laying examined. Nothing could be seen, until at last it occurred to me to cut off a short length and test it. This was done by getting a fairly damp brick and laying the cable on top, putting one wire to the core and one to the brick.

The leakage deflection was reproduced, and on carefully overhauling the cable a small portion was found touching the brickwork of one of the walls. It was then ascertained that a new outside compound had been tried on this cable in manufacture, which caused the insulation to be a partial conductor, and thus rendered it unfit for active service. (Fig. 8.)

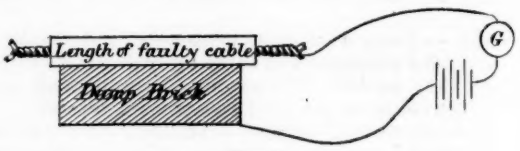


FIG. 8.

Automatic Leakage Detector.—It is often the case to find the insulation of an installation, which was at first many thousand ohms, fall rapidly from some cause or other after short use. I should like to make the suggestion here that a very useful piece of apparatus might be invented, and if made sufficiently cheap would no doubt be specified in all large installations to indicate at once when the insulation resistance of the mains fell below a certain point. This might be left permanently on the circuit on both mains, with an arrangement to call attention if the resistance fell below a predetermined point.

CONCLUSION.

It has been very difficult to make anything like a connected story of these chapters of disasters from the nature of the subject of the paper. I trust, however, that benefit may be derived from the simple enumeration of these defects and their causes. There are several instances of breakdown here quoted of Brush machines. The Brush dynamo I consider the best in the market, and that the instances, many of them from this class of dynamo, is simply from the fact that I have had more experience with this than any other class.

In conclusion, I must thank several of my friends who have been kind enough to assist me with tit-bits from their own experience.

EBEL'S COMBINED MORSE INK WRITER AND SOUNDER.

AN exceedingly compact and well arranged combined Morse ink writer and sounder has recently been brought out by Mr. J. Ebel. Although the ordinary Siemens ink writer when working will usually give sufficient sound to enable the signals to be read by the ear, yet this reading cannot be effected with any degree of comfort, and the arrangement devised by Mr. Ebel, although possibly not the first of its kind, is certainly the best yet designed for the purpose, and is an exceedingly good example of a properly worked out mechanical combination.

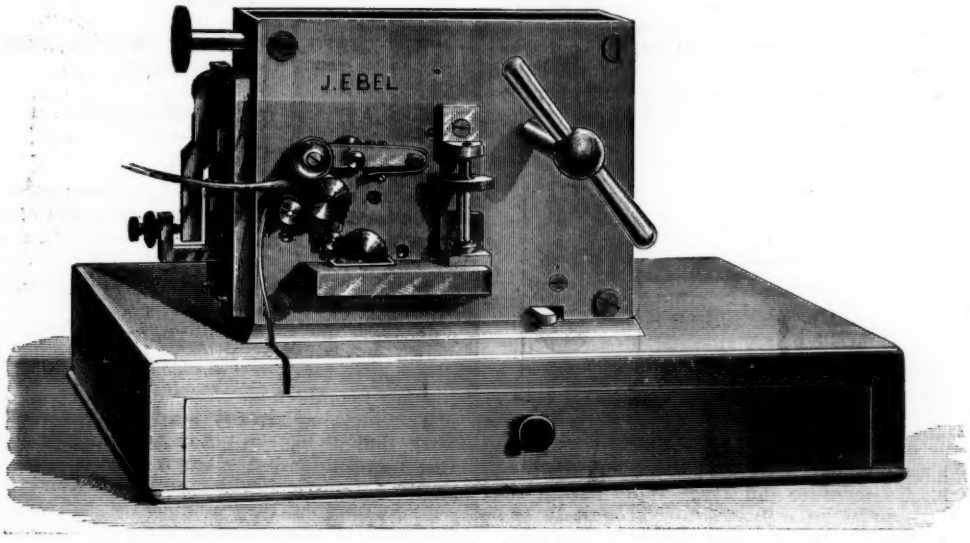


FIG. 1.

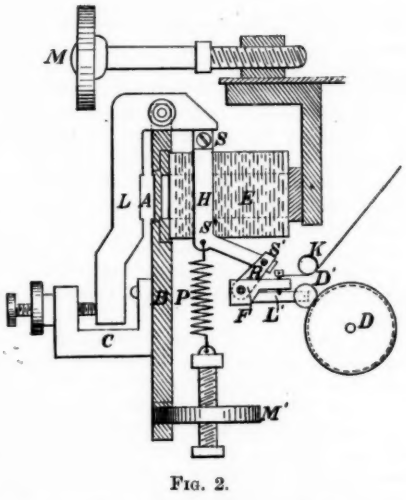


FIG. 2.

Fig. 1 represents a general view of the instrument. The position of the adjusting mechanism at the left side of the instrument is most convenient, being within easy and ready reach of the operator; and, moreover, the low position of the tape drawn by clockwork from the drawer enables a clear view of the recorded signals to be obtained.

Figs. 2 and 3 show sections of the electrical and mechanical arrangements of the instrument. The electro-magnet, E, is placed horizontally, and provided with a sliding arrangement and adjusting screw, M, to regulate its position with regard to its magnetic attracting power towards the armature, A.

The lever, L, with the attached armature, A, is placed in a vertical position, and the "play" of its action is controlled by the contact points of the piece, C.

To produce clearness of sound in the signals the piece, C, is attached to a wooden sounding board, B.

Through the medium of the metal piece, H, (made of light flat steel) the lever, L, is connected with the spiral spring, P, at point, S and S'', and further connected at S' with the pivoted axle, a', by the fixed arm, R, the tension of spring, P, being adjusted by the screw, M'.

The inking discs, D and D', are arranged similarly to those of the Wheatstone receiver.

The small marking disc, D', is fixed on axle, a, controlled by the clockwork (not shown).

The axles, a and a', are united through the light

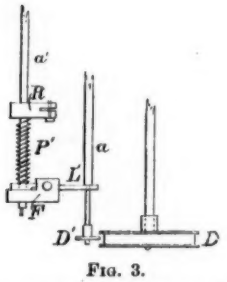


FIG. 3.

lever, L', without interfering with the freedom of movement in their bearings. Axle, a', is provided with a fine spiral spring, P', fixed to the small lever, L, in such a way as to constantly draw the said lever, with its carrying axle, a, towards the arm, F.

The arm, F, is stationary, fixed to axle, a', and provided with a small adjusting screw, which is so placed as to allow the marking disc, D', slightly to touch the tape passing under the stud, K.

The sound produced by the armature of the instrument is as equally clear and certain as with the best form of sounders; the ink writing mechanism is of very light construction, and is susceptible of very sensitive action, and in no way interferes with the production of sound. The form of the instrument is compact, and reduced to perfect simplicity. The mechanism for regulating the tension of the spiral spring, and for adjusting the electro-magnet, is of solid construction, and is placed in a more convenient position than has hitherto been the case.

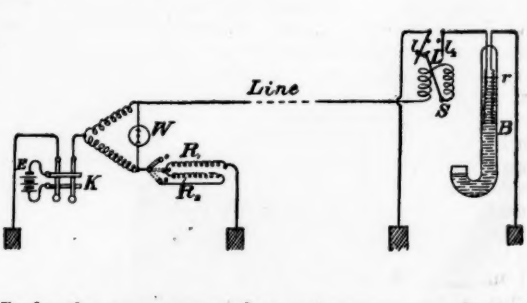
The instrument is well adapted for portable purposes, and would be found suitable for field telegraphs.

It has already been adopted by several telegraph companies, and is said to give great satisfaction.

JOHNSON STEPHEN'S ELECTRICAL BAROMETER.

THE object of this apparatus is to enable the height of the barometrical column to be ascertained when the instrument is placed at a distance from an observatory. The general idea of the invention is not, we believe, novel, but the means by which it is carried out is decidedly new and ingenious. The principle of the apparatus is as follows, and is shown by the figure.

B is the barometer tube placed at a distance from the observatory station, and connected to the latter by a single line wire. Through the upper end of this tube the wire, or carbon filament, resistances, r, are inserted; these resistances dip down into the mercury, which short-circuits them, so that the actual portions of the wires or filaments offering resistance will obviously vary as the column of the mercury rises or falls. To determine, therefore, the height of the column, we have only to measure the resistances, r. In actual practice these resistances would measure about 5 ohms to the inch.



So far the arrangement does not possess any distinctive feature. To measure the exact value of the resistances, r, we must, of course, know accurately the value of the "line" resistance, as this must be deducted from the total measured resistance, in order to determine the value of r. Now if the line resistance were a constant quantity, there would be no difficulty in determining r by a single measurement; but, of course, as is well known, the line resistance constantly varies, and it is the getting over of this point that constitutes the special feature of Mr. Stephen's invention. Connected in circuit with the line is a special form of automatic switch, S′, a form which was described in the No. of the REVIEW for July 30th, 1886, page 115, in connection with an automatic individual telephone call arrangement, also the invention of Mr. Stephen. This switch enables the line current to be diverted at the receiving end of the line from one circuit to another, as required, by causing the line current to pass in one direction or the other. The line current, it will be seen, passes through the magnet coils of the switch, and thence through a polarised armature, and then from the end of this armature to one or other of the two levers, l_1 l_2, according as the lever is over to the left or right; to effect which result the arrangement is such that contact is not broken from one lever until it is made with the other, so that the continuity of the line remains unbroken. The lever, l_2, is connected to the barometer resistances, and the lever, l_1, to earth direct.

At the observatory station a Wheatstone bridge, W, is arranged with a double key, K. The adjustable resistance of the bridge is in two parts, R_1 and R_2. s is a three position switch; in position 0 this switch is disconnected; in position 2 it is connected to resistance R_1, and in position 3 to resistance R_2.

The working of the whole arrangement is as follows:—The switch, s, being in position 0, the left hand pedal of the key, K, is depressed; this sends a current from the battery, E, direct to line, and actuates the switch, S′, so that its armature moves over to the lever, l_1, putting the line direct to earth through the coils of the switch. The hand switch, s, is then moved over to position 1, and balance is obtained on the galvanometer by adjusting R_1; this resistance then will be the resistance of the line wire and the coils of the witch, S′. Switch, s, is then moved back to 0, and the right hand pedal of the key, K, is depressed. This causes a current to be sent, which moves the armature of S′ over to l_2, thus putting the resistances, r, in circuit. Switch s is now moved to 2, and balance is obtained by adjusting R_2. Since R_1 is still in circuit, it is obvious that the resistance, R_2, must be the resistance of r, hence we get the value of r quite independent of the value of the line resistance.

It must be obvious that the whole arrangement is adaptable not only for the measurement of the height of a barometric column, but for thermometers as well, and indeed for several other purposes.

THE INSULATION OF MAINS FOR HIGH TENSIONS.

By G. L. ADDENBROOKE.

III.

So far these articles have chiefly been taken up with an enumeration of the properties of high tension currents and their action on insulating materials or dielectrics as they affect this problem. The last article closed with a brief *resumé* of these properties and a description of the rational method the civil engineer is able to adopt in designing and laying water pipes which present difficulties of an analogous nature, if different in kind, to those which occur in dealing with insulated conductors.

The fact has already been brought out experimentally that dielectrics not only act as so much more or less non-conducting space interposed between a conductor and other conductors, or semi-conductive bodies outside, but that they also possess in a high degree the power of resisting the disruptive action of the current, much in the same way as the tensile strength of iron prevents the internal pressure from bursting up water pipes. But while a sound water pipe prevents any water coming out through it, even the best dielectrics allow some current, though infinitesimal in amount, to flow through their substance.

This power of a sound dielectric to resist the disruptive action of the current is the chief safeguard to rely on in constructing and using cables for high tension currents. Further safeguards can be introduced, such as a thick covering of insulating material, so as to present a broad surface for the current to travel over where there is any defect, but this is of secondary importance. The fundamental requisite of a successfully insulated conductor is a perfectly continuous and uniform covering of a sound and mechanically satisfactory dielectric of sufficient thickness to withstand the disruptive effect of the current.

In what follows, I wish particularly to point out that my remarks are intended to apply only to dielectrics and the construction of cables to be used with high tension currents. A good deal naturally cannot help being applicable to conductors used for low tension currents, but there is as much difference between currents of 100 volts and 2,000 volts as between steam pressures of 15 lbs. and 300 lbs. per square inch. A boiler made to stand 300 lbs. pressure would naturally raise steam very nicely at 15 lbs.; but to design and construct a boiler with the modifications in construction and strength to withstand the higher pressure, when the lower only was to be used, would be uneconomical, to say the least of it.

The principles on which engineers go in designing boilers and water pipes and bridges—in fact, nearly all things mechanical which have to stand strains, and in which cost is a consideration—is, first of all, to find out what strain the things will have to stand. Knowing the strength of the materials which are to be used, sizes are soon calculated. The additional strength to cover chance defects, and as a factor of safety, is then added on afterwards.

Although it would be highly desirable to design cables in the same way, so far the elaborate and careful experimental data, checked and corrected by practice, which we have to hand, where metal work is concerned, are in a great measure wanting for our present purpose.

Still the general facts already detailed, and the knowledge we have of the subject, taken together and correlated with what has so far been found practically successful, are sufficient, I think, to enable a pretty fair approximation to be made.

If conductors for high tension currents are carried on insulators or on suspenders made off on insulators, the insulators themselves will be amply sufficient to withstand the whole strain of the current, and the provision of any covering is of use only as a facility for working, and to guard against accidents which might happen from the conductors being touched, or from short circuits or fires which might occur should the poles carrying the cables fall over from any cause. Now there is no place which is more trying to insulating materials than overhead in towns. The atmosphere is full of smoke and acid vapour, the temperature alternates from the blazing heat of the summer sun to the extreme cold of a clear winter's night, and lastly the outer coverings of the cables are constantly being soaked with rain and then dried to parching. If any mishap occurs to cables so erected, and they fall down on the roofs of houses or into streets (*absit omen*), they are then in a position where as good insulation is requisite as underground. It therefore seems desirable that overhead cables in towns and populous places should, as a rule, be as effectively insulated when high tension currents are used as if the conductors were placed underground ; at any rate for the present, and until the public are more accustomed to hear of high tensions, and engineers to use them.

Again, when conductors are laid underground, the strain on the dielectric will vary as they are laid in bitumen, in pipes, or in culverts ; but as the strength of a chain is its weakest link, so it is not safe to assume that water will not somewhere get into even a bitumen conduit.

For these reasons in dealing with insulation, I shall assume that sufficient coverings are to be put on to withstand the current when the cable is in water or in a damp place. Having once arrived at what is requisite for this, allowances can be made for less trying circumstances, or where the insulated conductor is enclosed in an impervious metallic sheath, such as a lead pipe. Moisture is the electrical engineer's great enemy ; it is in combatting its presence and keeping it away, that the greatest amount of energy and foresight is needed.

In order to throw as little strain as possible on the insulating coverings while the cable is being handled and laid or erected, the conductors should be stranded, and the strands should be kept small. As a rule I think no single wire larger than No. 18 S.W.G. should be used, the extra expense of this is small, and is amply compensated for by the increased pliability attained, and the greater ease with which the cable can be laid straight and without kinks and bends. A fine strong tape should be wound round the conductor, so as to keep the strands together, and prevent them opening out and straining the insulation, if the cable gets twisted the wrong way round, which will sometimes happen.

To form the dielectric on insulating coverings three materials are available : India-rubber, gutta-percha, and some of the bituminous compounds, natural or artificial. Into the relative merits and demerits of these three materials I do not propose to enter. It is a large subject replete with side issues, to enter into which would be rather confusing, and would tend to make these articles more speculative than immediately practical. It is sufficient to say that while bitumen on account of its cheapness and durability is probably the dielectric of the future as gutta-percha has been that of the past, so in Europe at least for high tension work India rubber is the dielectric of the present. India rubber is the dielectric which has been chiefly used for high tension work so far, and about whose behaviour we have most experience. As the minds of electricians are more exercised at present on the question whether high tension work underground can be done at all, than occupied with thinking in how many different ways it may be possible to do it. I shall, therefore, without wishing in any way to depreciate the value of other dielectrics, take rubber as the one which will be used.

High class India rubber covered cables are usually coated with three distinct kinds of rubber. A thin inner covering of pure rubber, a second layer of "zinc rubber," or rubber containing zinc oxide and vulcanising materials, an outer layer of compound or black rubber also containing vulcanising materials.

On the top of of the tape round the conductor at least three separate coverings of pure India-rubber strip should be wound with a good lap everywhere, and the rubber should not be so tightly stretched while this is done as to cause it to lose its elasticity. This rubber should be fresh and pure, with clean surfaces, so that the layers may afterwards unite perfectly together. By putting on at least three layers absolute continuity is ensured ; it is, I think, better that the layers should be put on spirally than longitudinally in a closing machine. This covering of pure uniform rubber will form our fundamental continuous coating. At least as great a thickness should be put on as the distance a spark will leap through air with the current to be used on the cable, and if the distance is less than these layers come to, for mechanical reasons a less thickness should not be put on. At 4,000 volts tension a covering on this basis would be about $\frac{1}{16}$th of an inch thick, which would mean seven or eight layers at least. Such a thickness for such a voltage is not much, and it would, I am sure, be sufficient when in good order to keep the current in.

On the other hand, on the same basis, at 1,000 volts tension the covering would only need to be $\frac{1}{250}$th of an inch thick ; but this, for mechanical reasons, is too thin, and therefore at least three good layers of rubber, amounting to, say, $\frac{1}{20}$th of an inch in thickness, should be put on.

If this strip is pure and free from defects, as it should be, and the surface not oxidised, the layers will unite together at the heat used for vulcanising, and make a perfectly continuous and uniform covering, sufficiently thick to resist the disruptive tendency of the current, and at the same time having a very high insulation resistance. This covering will be strong and elastic, and if protected from heavy strains and contact with hard substances, will stand well the handling and bending which takes place in laying. Further, we know that protected from light and atmospheric influences such pure rubber will remain sound a long time ; in fact, I do not think there is anything yet to show what is the limit of durability of rubber kept under such circumstances. I wish, however, to make one reservation here, and to lay stress upon it. It is well known that pure rubber becomes very hard and stiff, and loses its elastic qualities at low temperatures anywhere near the freezing point. Those who use plain rubber for taking out pencil marks know how hard and intractible it gets in winter. To subject the thin covering round a conductor to the heavy strain of bending or motion at all when it is very cold and in this state is unwise, and it is worthy of the consideration of engineers who may be responsible for laying cables which are afterwards to be used for high-tension currents whether it is not false economy to attempt handling them if the temperature is under, say, 45° F.

Having got this covering of pure rubber on the conductor, it remains to protect it from outside influences, mechanical and atmospheric, to strengthen its resisting qualities by the addition of further dielectric materials, and at the same time to provide a broader non-conductive surface over which the current would have to travel if a fissure from any cause occurred. To do this a covering of "zinc rubber" should be added, as thick as the layer of pure rubber, and outside this

another layer of black, a compound rubber of similar thickness, the same precautions and care being taken to secure the good quality and homogeneity of these materials and the continuity of the coverings as with the pure rubber. Taking as a minimum the thickness of the pure rubber coating at $\frac{1}{20}$th inch, we shall then get a total thickness of insulation of $\frac{3}{20}$th inch, or rather over $\frac{1}{8}$th inch. I do not think, for mechanical reasons and judging from practical experience, that it is advisable to put on a much thinner covering of dielectric than $\frac{1}{8}$th inch if it is intended to last and stand such usage as mains are likely to meet with in the ordinary course of things. At the same time, such a covering will, on the principles laid down, be amply sufficient to stand a tension of 2,000 volts. With such a tension, if a fissure should occur, the thickness of the insulation will be more than six times the surface breadth a spark will pass in air. Each of the coverings, moreover, if perfectly continuous, is alone amply thick, with a good margin, to withstand the disruptive effect of the current.

When all the coverings are on the conductor, a good proof tape should be lapped round outside. In the curing process this tape gets amalgamated to the outer surface of the rubber and forms a strong covering to it. Great care is requisite in the vulcanising process to see that at the heat to which the rubber is raised, it does not get so soft as to allow the conductor to sink through it or compress it on one side and so leave that side with a thinner coating, which may happen if the conductor is a heavy one and proper precautions are not taken.

A cable carefully made up in this way of first-class materials is one in which the electrical engineer can put every confidence. With slight modifications, it is practically the same cable as has been used underground so successfully at Eastbourne, and is also similar to a type which I got out after careful enquiry and consultation for the Grosvenor Gallery installation, and which has since been largely used with entire success.

In what I have said above I have recommended proportionately rather a thicker covering of pure rubber and rather thinner coverings of the two compound rubbers than it has so far been usual to employ in practice. I do so partly for the principle of the thing as I have laid it down, and because it then forms, so to speak, some sort of a basis on which to work, but also for other more immediately practical reasons. The first is that by employing such a coat of pure rubber the sulphur does not get at the copper conductors as it does if the covering is very thin, and so it is not worth while tinning them, which is a saving of expense; and, again, it is easier to make a sound and satisfactory joint with pure rubber than with the vulcanised and compound articles. As the facility with which satisfactory joints can be made is one of the most important points about a dielectric, this is a reason in favour of the thicker covering of pure rubber not to be overlooked.

THE COPENHAGEN EXHIBITION.

THE electric illumination of the grounds and different departments separated from the main hall of this exhibition is effected by means of 10 dynamo machines, calculated to give a total electric output of about 65,000 watts. The following particulars may not be entirely without interest, although they are devoid of technical value, as no actual measurements are obtainable of the mechanical energy expended by the engines, and the whole installation has been carried out without regard to economy.

One shunt-wound dynamo of the Weston type with Gramme ring, and made by Messrs. Palmcrantz & Co., Stockholm, feeds 60 glow lamps of 16 candles each, and three large arc lamps (12 ampères each). It is driven at the rate of 820 revolutions per minute, and produces 8,000 watts (80 ampères at 100 volts).

One series-wound dynamo of the same type as above, and by the same maker. It makes 1,180 revolutions per minute, delivers about 4,500 watts (10 ampères at 450 volts), and maintains nine large arc lamps.

One dynamo (Hauberg's patent), with the base and the one pole of the field magnet cast in one piece, which arrangement saves a coil and reduces the cost. This machine works at the rate of 400 revolutions per minute, and yields 5,000 watts (50 ampères at 100 volts). It feeds 36 glow lamps (Edison's) of 16 candles each, and four other (5 ampères) glow lamps of 200 candles each.

One dynamo of the Edison type, which at the rate of 950 revolutions per minute, gives an output of 10,000 watts (100 ampères at 100 volts), and maintains 22 arc lamps in parallel circuit.

One series-wound dynamo of Schuckert's make. It gives 4,000 watts (8 ampères 500 volts), when revolving 850 times per minute, and feeds 10 arc lamps in series.

One compound dynamo, also of Schuckert's type. This machine makes 1,100 revolutions per minute and delivers 5,000 watts (50 ampères, 100 volts). It feeds 60 glow lamps of 16 candles each, and 4 arc lamps of 6 ampères each.

One Siemens and Halske compound dynamo. It makes 1,300 revolutions per minute, and feeds, with an output of 30 ampères at 65 volts, 6 Siemens arc lamps, each of 3 ampères, and 10 glow lamps of 16 candle-power each.

One Jürgensen dynamo with an output of 200 ampères at 65 volts, and a speed of 700 revolutions per minute, feeds 4 arc lamps of 10 ampères each, 4 arc lamps of 5 ampères each, 20 glow lamps of 16 candles each, and 8 arc lamps of 10 ampères each.

One Siemens dynamo, 400 revolutions per minute, and delivering 150 ampères at 65 volts. It is driven by an engine coupled on to the shaft direct.

The Army and Navy Court has a Siemens Brothers compound dynamo, worked by a Brotherhood engine. It feeds 14 arc lamps at 10 ampères, and some few glow lamps.

The whole of the plant is in capital working order. No hitch has as yet occurred, the light is everywhere steady and brilliant, and the installation does great credit to those who have the management of it.

MELBOURNE CENTENNIAL EXHIBITION.

THE arrangements for the lighting of the Melbourne Exhibition building with electricity were well under way when our advices left. The Australasian Electric Light, Power and Storage Company holds the contract for the Exhibition building and the main annexes. To give some idea of the magnitude of this part of the work, it may be stated that about 27 miles of leads have been used. The installation is being carried out under the personal supervision of Mr. R. E. Fletcher, the company's electrical engineer, who also carried out the lighting of the Adelaide Jubilee International Exhibition last year. The systems adopted are the Brush arc and Brush-Victoria incandescence systems. The lighting of the Melbourne Exhibition will, it is said, far exceed anything that has hitherto been attempted in this direction. The contract is for 825 10-ampère Brush arc lamps, and 2,000 Swan 16 C.P. incandescence lamps, with the necessary dynamo machines, conductors, fittings, &c. There will be 37 Brush dynamos, each capable of supplying electric current to 23 Brush arc lamps, and 7 Brush-Victoria dynamos, each supplying current to 350 Swan incandescence lamps. Power for driving the machines will be supplied by six horizontal engines, coupled in pairs, each pair capable of giving about 500 horse-power. Steam for these engines will be supplied from twelve boilers. Every precaution is being taken against a failure of the light. Either pair of engines can be disconnected from the countershaft in the event of a mishap to one of them. The countershaft is divided into several sections, and any of the dynamos can be

stopped without interference with the others. A spare arc and a spare incandescence dynamo is provided in case of an emergency, and could be quickly substituted for a defective machine.

The arc lamps will be arranged so that no two lamps supplied with current from the same machine come together, there being two or three lamps supplied with current from two or three other machines intervening. The advantage of this is obvious, as, in the event of an accident from any cause to one of the dynamos, only a fourth of the lamps in any particular court would be extinguished, until the defective machine was replaced by the spare one, which it is said would be the work of a few minutes only. In the main building, the dome, naves, and transepts will be lighted with Brush arc lamps, and the picture galleries, wine cellars, the space under the galleries in the main hall, the aquarium, retiring rooms, offices, &c., will be lighted with the Swan incandescence lamps. In the annexes the Brush arc lamp will also be employed. The total area to be lighted is as follows :—Arc lighting, 943,135 square feet of floor space, or about 1,144 feet per lamp; incandescence lighting, 119,000 square feet floor space, about 58 square feet per lamp. The incandescence lighting is on the direct continuous current system, the lamps being supplied with current direct from the dynamos without the intervention of transformers or accumulators.

The seven incandescence dynamos that will be used here are compound wound and will be joined up in "parallel," so that each machine contributes a proportional amount of the total current that may be required at any time. This makes practically one machine of the seven, the work being distributed evenly amongst them all, but with the advantage that one or two of the machines could be disconnected from the circuit in a few seconds if necessary.

Messrs. Ganz & Co. are to light up the reception rooms with about 200 incandescent lamps of 16 candle-power, and the armament court and part of the machinery annexe, covering about 30,000 square feet of space, with 30 arc lamps, the whole of which will be worked on the transformer system. Messrs. W. H. Masters & Co. have made an offer to light the western machinery annexe with 78 arc lamps of 2,000 candle-power, but the contract had not been let when our information left.

AN ADVANCE IN PRIMARY BATTERIES.

AMONGST the essentials which go to form an ideal primary battery we must have, according to Professor Silvanus Thompson, a high electromotive force, a low internal resistance, and a constant current for a considerable period of time. It appears that these conditions have been complied with in the improved form of Bunsen battery on which M. Weymersch has been working for the past three years. It has long been known that the Bunsen, Grove, and Bichromate types of battery are the most powerful sources of galvanic electricity; but hitherto they have all had the disadvantage of being very inconstant, and of giving a powerful current of but short duration. Anything, therefore, which tends to lengthen the period over which a battery of the Bunsen type will give an approximately constant current, may be considered as a distinct advance in primary batteries.

The only claim which M. Weymersch makes is for a new depolarising liquid, which appears to possess great advantages over anything which has been before discovered. The inventor does not for one moment pretend that he will ever supersede dynamos, but he has great faith in the utility of his battery for small installations in country houses, and any place indeed in which the outlay on dynamos and their engines will be considered too great. For charging accumulators M. Weymersch thinks his battery will be specially useful, as by this means the maximum electrical energy of the combination will be obtained. He estimates that one battery of 12 cells of the sizes specified in the tests mentioned further on, would be sufficient to charge the accumulators with electrical energy equal to 5,400 watt-hours, or 45 candle-power for 6 hours per day for a week. The cost of this, at the market price of the materials used, he calculates to be as follows :—zinc, 2s., 18 quarts of the depolarising liquid, 2s. 7d., and sulphuric acid, 5d., total, 5s., or an outlay of 9d. per day of 6 hours for 45 candles.

M. Weymersch has also great hopes that his battery will be extensively employed for torpedo work, for driving electro-motors, for miners' lamps, and, indeed, for every purpose to which a strong and comparatively constant current can be put for a considerable time.

We will now give our own experiences with this improved type of cell.

A preliminary trial was made with three cells with square open jars, each having the following internal dimensions :—8¼ inches × 8¼ inches × 12 inches deep. The quantity of liquid, sulphuric acid and water in the proportions of 1 to 20 parts in each jar, was about 16 pints. Immersed in this solution, to the depth of 6½ inches, were two 6⅜-inch wide zinc plates. Between the zinc plates, and placed in a porous pot 7¼ inches × 1½ inches × 12 inches deep, containing nearly 3¾ pints of the depolarising fluid, was the carbon electrode of the same linear dimensions as the zincs. These cells were connected in series to an ampèremeter, the current being adjusted by iron wire resistances to 10 ampères or thereabouts, and kept in circuit for 26 hours.

TABLE.

Date.	Time.	Duration (*t*)	Current (*c*) amps.	E.M.F. Volts. Open.	E.M.F. Volts. Closed.	Resistance per cell. Ohms.	C E *t* (external circuit). Watt hours.	Theoretical weight of zinc dissolved. Grammes per cell.	Actual weight of zinc dissolved. Grammes per cell.	Difference between theoretical and actual consumption. Per cent.	Remarks.
June 7th	11.0 a.m.	...	10·1	9·26	5·70	·070	...	...	...	...	
	12.0 „	1	10·4	...	5·75	...	58·97	12·436	...	...	
	1.0 p.m.	1	10·4	9·26	5·90	·065	60·58	12·618	...	...	From 7.30 p.m. on the 7th June to 11 a.m. on the 8th the battery was left to itself 15½ hours.
	2.0 „	1	10·4	...	6·04	...	62·09	12·618	...	...	
	3.0 „	1	10·5	9·26	6·04	·061	63·12	12·679	...	...	
	4.0 „	1	10·5	...	6·08	...	63·63	12·740	...	...	
	5.0 „	1	10·6	...	6·08	...	64·14	12·800	...	...	
	6.0 „	1	10·6	9·26	6·08	·060	64·45	12·861	...	...	
	7.0 „	1	10·6	...	6·08	...	64·45	12·861	...	...	
	7.30 „	½	10·6	9·08	6·08	·057	32·22	6·430	...	...	Current density 0·12 ampères per square inch.
June 8th	11.0 a.m.	15½	10·5	9·06	5·89	·060	978·70	198·400	...	...	
	12.0 „	1	10·4	...	5·85	...	61·34	12·679	...	...	
	1.0 „	1	10·3	9·06	5·85	·062	60·55	12·558	...	...	
	2.0 „	1	10·3	...	5·85	...	59·65	12·497	...	...	
	3.0 „	1	10·2	8·95	5·75	·063	59·45	12·436	...	...	
	4.0 „	1	10·2	...	5·70	...	58·40	12·376	...	...	
	5.0 „	1	10·1	8·95	5·70	·064	57·86	12·315	...	...	
	6.30 „	1½	10·0	8·95	5·65	·066	85·54	18·290	...	...	
...	...	31½ hrs.	...	...	...	... per cell	1955·14 = 391	399·594	439·7	10·0	...

The results obtained showed that the current did not vary more than 5 per cent. during this period, and that the difference between the maximum and minimum free potential of the cells was less than 5 per cent., with the working or available electromotive force slightly rising.

We then took five cells of similar dimensions, and kept them in circuit for 31½ hours with the result shown in the table, and doubtless several hours more work could have been obtained before the electrical constants were reduced to the extent of rendering it undesirable to prolong the test. It will be observed that the free potential of the battery did not vary more than approximately 3 per cent., that the working electromotive force was practically the same at the end of the test as at the beginning, and that the current varied only between 10 and 10·6 ampères. The actual and theoretical consumption of zinc differ by only 10 per cent., which corresponds very nearly with that obtained in the preliminary trial, and which shows that there is but little local action going on.

The price per horse-power hour agrees more closely with the theoretical cost of batteries in which zinc is consumed than that of any other type with which we are acquainted, although the precise figure will of course depend much upon the charge the inventor chooses to make for his depolariser in quantities, which, we are informed, can be manufactured at a cost of 6d. per gallon.

We shall be glad to know whether any of our readers can point to results previously obtained which approach these, for until we have evidence to the contrary, we can only come to the conclusion that M. Weymersch has so far made the nearest approach to an ideally perfect primary battery.

It was noticed during the tests that the solutions did not appear to rise in temperature, and although after a time fumes arose from the battery, there is no reason why these should not be rendered more or less unobjectionable by the employment of proper devices.

The measuring instruments which we employed were very kindly lent us by Messrs. Sharp and Kent, and their calibration was independently checked by Mr. H. R. Kempe and Mr. W. M. Mordey.

Many primary batteries have during the past few years been brought before the public notice; several of the best known have been tested in our offices at the cost of much time and trouble, but until now the results have been anything but satisfactory. Those who are in the habit of using strong galvanic elements have, doubtless, had occasion to remember their experiences and will all the more appreciate the advantages of a battery which can be kept in constant and hard work for a period of, say 40 hours, a period which we need scarcely say can be lengthened by employing a smaller current, and *vice versa*. If further information respecting the Weymersch battery is desired, we shall be happy to give it.

A NEW SYSTEM OF ALTERNATE CURRENT MOTORS AND TRANSFORMERS.*

By NIKOLA TESLA.

(*Continued from page* 649.)

In applying this principle to the construction of motors, two typical forms of motor have been developed. First, a form having a comparatively small rotary effort at the start, but maintaining a perfectly uniform speed at all loads, which motor has been termed synchronous. Second, a form possessing a great rotary effort at the start, the speed being dependent on the load.

These motors may be operated in three different ways:—1. By the alternate currents of the source only. 2. By a combined action of these and of induced currents. 3. By the joint action of alternate and continuous currents.

The simplest form of a synchronous motor is obtained by winding a laminated ring provided with pole projections with four coils, and connecting the same in the manner before indicated. An iron disc having a segment cut away on each side may be used as an armature. Such a motor is shown in fig. 9. The disc being arranged to rotate freely within the ring in close proximity to the projections, it is evident that as the poles are shifted it will, owing to its tendency to place itself in such a position as to embrace the greatest number of the lines of force, closely follow the movement of the poles, and its motion will be synchronous with that of the armature of the generator; that is, in the peculiar disposition shown in fig. 9, in which the armature produces by one revolution two current impulses in each of the circuits. It is evident that if, by one revolution of the armature, a greater number of impulses is produced, the speed of the motor will be correspondingly increased. Considering that the attraction exerted upon the disc is greatest when the same is in close proximity to the poles, it follows that such a motor will maintain exactly the same speed at all loads within the limits of its capacity.

To facilitate the starting, the disc may be provided with a coil closed upon itself. The advantage secured by such a coil is evident. On the start the currents set up in the coil strongly energise the disc and increase the attraction exerted upon the same by the ring, and the currents are generated in the coil as long as the speed of the armature is inferior to that of the poles. Considerable work may be performed by such a motor even if the speed be below normal. The intensity of the poles being constant, no currents will be generated in the coil when the motor is turning at its normal speed.

Instead of closing the coil upon itself, its ends may be connected to two insulated sliding rings, and a continuous current supplied to these from a suitable generator. The proper way to start such a motor is to close the coil upon itself until the normal speed is reached, or nearly so, and then turn on the continuous current. If the disc be very strongly energised by a continuous current the motor may not be able to start, but if it be weakly energised, or generally so that the magnetising effect of the ring is preponderating it will start and reach the normal speed. Such a motor will maintain absolutely the same speed at all loads. It has also been found that if the motive power of the generator is not excessive, by checking the motor the speed of the generator is diminished in synchronism with that of the motor. It is characteristic of this form of motor that it cannot be reversed by reversing the continuous current through the coil.

The synchronism of these motors may be demonstrated experimentally in a variety of ways. For this purpose it is best to employ a motor consisting of a stationary field magnet and an armature arranged to rotate within the same, as indicated in fig. 13. In this case the shifting of the poles of the armature produces a rotation of the latter in the opposite direction. It results therefrom that when the normal speed is reached the poles of the armature assume fixed positions relatively to the field magnet and the same is magnetised by induction, exhibiting a distinct pole on each of the pole pieces. If a piece of soft iron is approached to the field magnet it will at the start be attracted with a rapid vibrating motion produced by the reversals of polarity of the magnet, but as the speed of the armature increases the vibrations become less and less frequent and finally entirely cease. Then the iron is weakly but permanently attracted, showing that the synchronism is reached and the field magnet energised by induction.

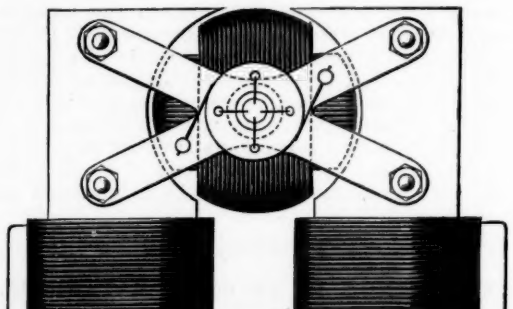


FIG. 13.

The disc may also be used for the experiment. If held quite close to the armature it will turn as long as the speed of rotation of the poles exceeds that of the armature; but when the normal speed is reached, or very nearly so, it ceases to rotate and is permanently attracted.

A crude but illustrative experiment is made with an incandescent lamp. Placing the lamp in circuit with the continuous current generator, and in series with the magnet coil, rapid fluctuations are observed in the light in consequence of the induced currents set up in the coil at the start; the speed increasing, the fluctuations occur at longer intervals, until they entirely disappear, showing that the motor has attained its normal speed.

A telephone receiver affords a most sensitive instructive instrument; when connected to any circuit in the motor the synchronism may be easily detected on the disappearance of the induced currents.

* Read before the American Institute of Electrical Engineers, May 16th, 1888.

In motors of the synchronous type it is desirable to maintain the quantity of the shifting magnetism constant, especially if the magnets are not properly subdivided.

To obtain a rotary effort in these motors was the subject of long thought. In order to secure this result it was necessary to make such a disposition that while the poles of one element of the motor are shifted by the alternate currents of the source, the poles produced upon the other element should always be maintained in the proper relation to the former, irrespective of the speed of the motor. Such a condition exists in a continuous current motor; but in a synchronous motor, such as described, this condition is fulfilled only when the speed is normal.

The object has been attained by placing within the ring a properly subdivided cylindrical iron core, wound with several independent coils closed upon themselves. Two coils at right angles are sufficient, but a greater number may be advantageously employed, as in fig. 14. It results from this disposition that when

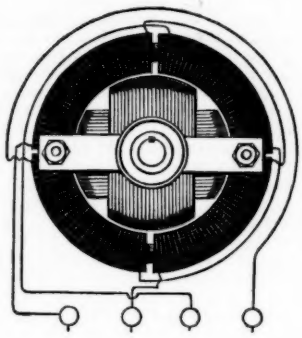


FIG. 14.

the poles of the ring are shifted currents are generated in the closed armature coils. These currents are the most intense at or near the points of the greatest density of the lines of force, and their effect is to produce poles upon the armature at right angles to those of the ring—at least, theoretically so; and since this action is entirely independent of the speed—that is, as far as the location of the poles is concerned—a continuous pull is exerted upon the periphery of the armature. In many respects these motors are similar to the continuous current motors. If load is put on, the speed, and also the resistance of the motor, is diminished, and more current is made to pass through the energising coils, thus increasing the effect. Upon the load being taken off, the counter electromotive force increases, and less current passes through the primary or energising coils. Without any load the speed is very nearly equal to that of the shifting poles of the field magnet.

It will be found that the rotary effort in these motors fully equals that of the continuous current motors. The effort seems to be greatest when both armature and field magnet are without any projections; but as in such dispositions the field cannot be very concentrated, probably the best results will be obtained by leaving pole projections on one of the elements only. Generally it may be stated that the projections diminish the torque and produce a tendency to synchronism.

A characteristic feature of motors of this kind is their capacity of being very rapidly reversed. This follows from the peculiar action of the motor. Suppose the armature to be rotating and the direction of rotation of the poles to be reversed. The apparatus then represents a dynamo machine, the power to drive this machine being the momentum stored up in the armature, and its speed being the sum of the speeds of the armature and the poles. If we now consider that the power to drive such a dynamo would be very nearly proportional to the third power of the speed, for this reason alone the armature should be quickly reversed. But simultaneously with the reversal another element is brought into action—namely, as the movement of the poles with respect to the armature is reversed, the motor acts like a transformer, in which the resistance of the secondary circuit would be abnormally diminished by producing in this circuit an additional electromotive force. Owing to these causes the reversal is instantaneous.

If it is desirable to secure a constant speed, and at the same time a certain effort at the start, this result may be easily attained in a variety of ways. For instance, two armatures, one for torque and the other for synchronism, may be fastened on the same shaft, and any desired preponderance may be given to either one, or an armature may be wound for rotary effort; but a more or less pronounced tendency to synchronism may be given to it by properly constructing the iron core, and in many other ways.

As a means of obtaining the required phase of the currents in both the circuits the disposition of the two coils at right angles is the simplest, securing the most uniform action; but the phase may be obtained in many other ways, varying with the machine employed. Any of the dynamos at present in use may be easily adapted for this purpose by making connections to proper points of the generating coils. In closed circuit armatures, such as are used in the continuous current systems, it is best to make four derivations from equi-distant points or bars of the commutator, and to connect the same to four insulated sliding rings on the shaft. In this case each of the motor circuits is connected to two diametrically opposite bars of the commutator. In such a disposition the motor may also be operated at half the potential and on the three-wire plan, by connecting the motor circuits in the proper order to three of the contact rings.

In multipolar dynamo machines, such as use the converter systems, the phase is conveniently obtained by winding upon the armature two series of coils in such a manner that while the coils of one set or series are at their maximum production of current, the coils of the other will be at their neutral position, or nearly so, whereby both sets of coils may be subjected simultaneously or successively to the inducing action of the field magnets.

Generally the circuits in the motor will be similarly disposed, and various arrangements may be made to fulfil the requirements; but the simplest and most practicable is to arrange primary circuits on stationary parts of the motor, thereby obviating, at least in certain forms, the employment of sliding contacts. In such a case the magnet coils are connected alternately in both the circuits, that is, 1, 3, 5 in one, and 2, 4, 6 in the other, and the coils of each set of series may be connected, all in the same manner, or alternately in opposition; in the latter case a motor with half the number of poles will result and its action will be correspondingly modified.

The employment of multipolar motors secures in this system an advantage much desired and unattainable in the continuous current system, and that is, that a motor may be made to run exactly at a predetermined speed irrespective of imperfections in construction, of the load, and, within certain limits, of electromotive force and current strength.

In a general distribution system of this kind the following plan should be adopted. At the central station of supply a generator should be provided having a considerable number of poles. The motors operated from this generator should be of the synchronous type, but possessing sufficient rotary effort to insure their starting. With the observance of proper rules of construction it may be admitted that the speed of each motor will be in some inverse proportion to its size, and the number of poles should be chosen accordingly. Still, exceptional demands may modify this rule. In view of this, it will be advantageous to provide each motor with a greater number of pole projections or coils, the number being preferably a multiple of two and three. By this means, by simply changing the connections of the coils, the motor may be adapted to any probable demands.

FIG. 15.

FIG. 16.

FIG. 17.

If the number of the poles in the motor is even, the action will be harmonious and the proper result will be obtained; if this is not the case, the best plan to be followed is to make a motor with a double number of poles and connect the same in the manner before indicated, so that half the number of poles result. Suppose, for instance, that the generator has twelve poles and it would be desired to obtain a speed equal to $\frac{1}{2}$ of the speed of the generator. This would require a motor with seven pole projections or magnets, and such a motor could not be properly connected in the circuits, unless fourteen armature coils would be provided, which would necessitate the employment of sliding contacts. To avoid this the motor should be provided with fourteen magnets and seven connected in each circuit, the magnets in each circuit alternating among themselves. The armature should have fourteen closed coils. The action of the motor will not be quite as perfect as in the case of an even number of poles, but the drawback will not be of a serious nature.

FIG. 18.

FIG. 19.

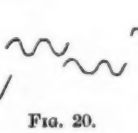


FIG. 20.

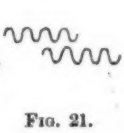


FIG. 21.

However, the disadvantages resulting from this unsymmetrical form will be reduced in the same proportion as the number of the poles is augmented.

If the generator has, say, n, and the motor, n_1, poles, the speed of the motor will be equal to that of the generator multiplied by $\frac{n}{n_1}$.

The speed of the motor will generally be dependent on the number of the poles, but there may be exceptions to this rule. The speed may be modified by the phase of the currents in the circuits or by the character of the current impulses or by intervals between each or between groups of impulses. Some of the possible cases are indicated in the diagrams, figs. 18, 19, 20 and 21,

which are self-explanatory. Fig. 18 represents the condition generally existing, and which secures the best result. In such a case, if the typical form of motor illustrated in fig. 14 is employed, one complete wave in each circuit will produce one revolution of the motor. In fig. 19 the same result will be effected by one wave in each circuit: in fig. 20 by two, and in fig. 21 by four waves.

By such means any desired speed may be attained; that is, at least within the limits of practical demands. This system possesses this advantage besides others, resulting from simplicity. At full loads, the motors show an efficiency fully equal to that of the continuous current motors. The transformers present an additional advantage in their capability of operating motors. They are capable of similar modifications in construction, and will facilitate the introduction of motors and their adaptation to practical demands. Their efficiency should be higher than that of the present transformers, and I base my assertion on the following:—

In a transformer as constructed at present, we produce the currents in the secondary circuit by varying the strength of the primary or exciting currents. If we admit proportionality with respect to the iron core, the inductive effect exerted upon the secondary coil will be proportional to the numerical sum of the variations in the strength of the exciting current per unit of time; whence it follows that for a given variation any prolongation of the primary current will result in a proportional loss. In order to obtain rapid variations in the strength of the current, essential to efficient induction, a great number of undulations are required and employed. From this various disadvantages result. These are, increased cost and diminished efficiency of the generator, more waste of energy in heating the cores, and also diminished output of the transformer, since the core is not properly utilised, the reversals being too rapid. The inductive effect is also very small in certain phases, and there may be periods of inaction, if there are intervals between the succeeding current impulses or waves. In producing a shifting of the poles in the transformer, and thereby inducing currents, the induction is of the ideal character, being always maintained at its maximum action.

BRIGHTON ELECTRIC RAILWAY.

As briefly reported in our last issue, the question of the proposed removal of Volk's Electric Railway formed the topic of an animated discussion at the last meeting of the Brighton Town Council. The Works Committee reported the receipt of a letter from Messrs. Olding and Olding stating that they had been instructed by an influential body of persons to take such steps as might be necessary against such person or persons, as they might be advised, for the speedy removal of the electric railway on the Madeira Road, which had been proved to be illegal. Before proceeding, however, they had deemed it well, as a matter of courtesy, to inform the Town Clerk of the course they intended to pursue. The committee now recommended that notice should be given Mr. Volk to move the railway from the beach within a month from the 24th inst.

Alderman BRIGDEN, in moving the adoption of the committee's recommendation, said that a few months since a proposal that six months' notice should be given Mr. Volk for the removal of the railway was negatived by a large majority. Since then the County Court judge had declared the railway to be, to a certain extent, a nuisance and a danger to the public. The railway had not been the success which had been anticipated, judging from the unfortunate position of Mr. Volk at the present time.

Councillor BLAKER seconded, stating that the Corporation had been threatened with an action by Messrs. Olding and Olding for permitting a nuisance on the Madeira Road. On being appealed to for their opinions, the Town Clerk and Borough Solicitor said that they could only give the same advice as they did on the last occasion, immediately after the decision of Judge Martineau—viz., that the railway was perfectly illegal, and that the Corporation could not possibly resist any action brought against them. Under those circumstances, the Corporation had no option but to bring up that report. The people of Kemp Town did not want the railway, although it was an attraction to day visitors. The removal of the railway at the present time would not be a hardship on Mr. Volk, and it was even questionable whether the plant had not, under the agreement existing between the Corporation and himself, become their property. It was a most opportune time to remove the railway at present, because the Corporation were about to spend £10,000 on the improvement of Madeira Road, and the latter could not be properly carried out if the railway were allowed to remain. The speaker also referred to the danger which the railway constituted to the driving public.

The TOWN CLERK denied having given an opinion in anything like the terms attributed to him by a previous speaker. Although he had not stated that the Corporation would be unable to resist any action brought against them, yet, considering the expressed opinion of Judge Martineau, and the difficulties which might arise, it was expedient that notice should be given.

Councillor HALL moved as an amendment: "That the council having on several occasions approved of the electric railway as an attraction in the eastern part of the town, do not deem it expedient to reopen the question until the improvements in the Madeira Road, lately sanctioned, are completed." The railway was constructed in 1884, since which time it had carried a million passengers, the total for 1887 being 240,000. This would show that the popularity of the line had been well maintained. There had only been two accidents in connection with the railway. In one case it was decided that it was not the fault of the railway, and in the other a bicyclist who was injured rode between a car and a horse, and it was a question whether the horse shied at the machine or at the car. The county-court judge went out of his way in the latter case to make some extra judicial comments, but when asked for an injunction he immediately retired from the situation. He ridiculed the idea of adopting such a resolution as the committee proposed on the strength of such a letter as that which had been received, and asked whether this was the time to deprive Mr. Volk of his daily bread. If the railway were kept on for a time it was probable that the creditors of Mr. Volk might be paid 10s. in the £.

The TOWN CLERK read the following portion of the agreement:—"I undertake if the railway shall be a nuisance, annoyance, injury, or danger to remove it and its appliances, and reinstate the beach within one week from the receipt of a notice in writing, and will indemnify the Corporation from any action arising from the said railway." If Mr. Volk assigned or parted with his interest in the railway, it was further stipulated that the agreement was to be void and the railway become the property of the Corporation. In his opinion, Mr. Volk had not made such an assignment as was contemplated by the agreement.

Councillor DELL (loudly): When a man's name is in the paper as a bankrupt you ought to know that he has made an assignment. And yet you tell us that he doesn't know. Our Town Clerk does not know. I am surprised at you. If an accident happened the Corporation would suffer for it.

The TOWN CLERK said the trustees in bankruptcy had not repudiated the agreement, and would be liable in case of accident.

Councillor HARKER said that he had always supported the railway as being an attraction to the town, and as affording amusement to people who were unable to keep their own carriages. Mr. Blaker had stated that the agreement provided that in case of bankruptcy it should be void; but it now appeared to be nothing of the kind. The railway had been running for years, and they had never yet been called upon to pay any claims. It was now being carried on for the benefit of Mr. Volk's creditors, many of whom were fellow townsmen.

Alderman ABBEY contended that the present was a very inopportune time to remove the railway, and said that the prospect of any accident was remote.

Councillor DANIEL described the report as "perfect bosh." In the name of common sense, he appealed to Alderman Brigden to withdraw the report.

Councillor STEVENS said that the committee wished to hit a man when he was down.

After further discussion the amendment was carried by twenty-one votes to seven.

LEGAL.

Pierce v. Liverpool Electric Supply Company.—Last week, in this case, before Vice-Chancellor Bristowe in the Liverpool Chancery Court, the plaintiff sought an injunction to restrain the company from working the machines at its supply station in Tithebarn Street in such a manner as to annoy him. It was stated that Mr. Pierce is an emigration agent and temperance hotel proprietor, carrying on business at 13, Highfield Street. The company has altogether three supply stations in Liverpool, and began work at the Tithebarn Street station, which is close to Highfield Street, in December, 1887. Upon these premises are two horizontal compound engines of 40 nominal horse power, each of which works an electrical machine. On several occasions the plaintiff had complained to the company that the vibration and noise occasioned by the engines and machines seriously injured his health and business, and he had also lodged a complaint with the medical officer of health for Liverpool, but no notice had been taken of the matter. His wife and sister, who until recently had enjoyed excellent health, had been in consequence of the nuisance partially incapacitated from attending to their domestic duties, and on that account the plaintiff had been obliged to incur medical and other expenses. It was further urged that a continuance of the nuisance might endanger the life of his wife, who was at present in a delicate condition of health, whilst the value of his hotel premises was also alleged to have been depreciated by the works of the company. The plaintiff is a yearly tenant, and since these proceedings were instituted the company has acquired the freehold, and caused a notice to quit on the 1st of June, 1889, to be served upon him. Mr. A. B. Holmes, managing director of the company, in the course of his evidence, stated that the engines had been constructed in such a manner that they would run as far as possible without vibration; otherwise the steadiness of the light would be affected. The cost of removing the relative positions of the boilers and engines to take the latter further from the plaintiff's house would be about £900 for labour and material alone.

At the adjournment, his Honour visited the premises of the plaintiff, and on resuming stated that he could relieve Mr. Hughes of the necessity of speaking with reference to anything except the scullery, kitchen, and room over the kitchen, in all of which the vibration was palpable. He considered the plaintiff was entitled to an injunction, but such an order would be a great hardship

upon the defendants owing to various circumstances. He considered remedy by damages would be the proper course to adopt. He would, therefore, either grant an enquiry for damages or, if agreeable to both sides, he would himself assess the damages. Both counsel agreed to the latter course, and his honour said he thought the justice of the case would be met by fixing the damages at £100, and ordering defendants to pay costs. With regard to the machinery of the defendant company, he must say that he never saw a better working plant for carrying on such a business than theirs was. Had the machinery been not so well constructed there would undoubtedly have been a far greater injury than at present existed.

Sir William Thomson v. Duncan M'Gregor & Co.—In the Court of Session last week was heard an action by Sir William Thomson, Professor of Natural Philosophy in the University of Glasgow, against Duncan M'Gregor & Co., nautical instrument makers, 37 and 38, Clyde Place, Glasgow, seeking to have the respondents interdicted from infringing his patent for the invention of "Improvements in the Mariner's Compass, and in the means for ascertaining and correcting its errors." The respondents denied that they had infringed the pursuer's patent rights. His Lordship, in granting an application for amendment of specification, said he thought that the respondents would not dispute that the instrument of Sir William Thomson—he would not call it his invention—was one of great merit and utility. The question remained for consideration at a future stage whether Sir William Thomson was the first and true inventor of this compass, or whether he had only made use of ideas previously furnished by others in the various specifications which were founded upon in this record. He (Lord M'Laren) interrupted the case because it appeared to him quite clear that there was an objection to the specification in regard to an instrument which was no part of the compass, but which was claimed as a convenient adjunct of the compass—namely, the detached azimuth circle. There must be nothing left to be supplied from independent information or scientific sources on the part of the operator beyond that information which was necessary for the ordinary conduct of his trade. While he was sorry the case should be delayed, he thought it was the proper course that an application should be made for leave to amend the description. Sir William Thomson was found liable in expenses up to date.

Gouraud v. the Edison Gower-Bell Telephone Company of Europe and the Consolidated Telephone Construction and Maintenance Company.—Mr. Justice Chitty has dismissed with costs an action by Colonel Gouraud, a shareholder in the Edison Gower-Bell Telephone Company, for an injunction to restrain the two defendant companies from carrying out an arrangement between them with reference to certain patent rights.

REVIEW.

Applications of Dynamics to Physics and Chemistry. By J. J. THOMSON, M.A., F.R.S., Fellow of Trinity College, and Cavendish Professor of Experimental Physics, Cambridge. London: Macmillan & Co.

This book contains the substance of a course of lectures delivered at the Cavendish Laboratory in 1886. The work is purely a mathematical one, and of but little interest to the practical worker; to the student of the higher branches of physics, however, the work is of decided value, as it relates to phenomena which belong to the borderland between two departments of physics, phenomena which are seldom touched upon.

Electric Lighting in Belgium.—The Thomson-Houston Company is actively pushing the electric light in Belgium. It is now proposed to light the Galerie du Roy in the Passage St. Hubert. The company has also been commissioned to light one of the largest spinning mills in Ghent. Messrs. Mourlon & Co. are paying special attention to private house lighting, for which purpose they are introducing a new American petroleum engine, which is of simple design and very steady in its running. Experiments made with it at the works of the firm proved very satisfactory, and it is now used in several installations of 15 to 50 lamps. The Comte de Flandre, the brother of the King, is having the electric light installed in his palace in the Place Royale, Julien accumulators being used; and Messrs. Mourlon are supplying plans for a large installation at Laeken for the King's palace.

NOTES.

Bath and the Electric Light.—A private meeting of the principal citizens of Bath (who are also the largest consumers of gas in the city), was held at the Grand Pump Room Hotel on the 15th inst., when it was decided to take at once the necessary steps for the formation of a local company for supplying Bath with the electric light for private and public use. It was decided to send in a tender to the Corporation for the lighting by arc lamps of a central area, at a price that would pay 5 per cent. upon the capital employed. Mr. Massingham, who was present, promised to find £5,000 of the capital required, and also to assist the company in other ways.

Hotel Lighting.—The Langham Hotel in Portland Place, one of the finest hotels in Europe, has just been lighted entirely by the electric light. The directors gave the contract to Messrs. B. Verity and Sons, of King Street, Covent Garden, who have carried out the work in a satisfactory manner. The power for supplying the necessary current is taken from the Grosvenor Gallery central station in Bond Street. The converters, of which there are eight, are placed in a specially constructed building in the yard at the rear of the hotel, and the secondary cables are run from thence to the different floors. Altogether, there are at the present time 1,400 lights; the whole of the cables and wires (of which there are many miles) have been manufactured especially for the purpose, as have also the different switches, safety fuses, electroliers, pendants, &c. The whole of the work has been completed in four months.

Ilfracombe and the Electric Light.—At the last monthly meeting of the Ilfracombe Local Board the Surveyor reported that in answer to an advertisement asking for tenders for lighting the Sheltered Promenade by electricity, he had received letters from a large number of firms, to whom he sent a circular letter explaining that the board would take no responsibility in regard to finding machinery for power. In answer to this five firms had declined to have anything to do with the matter, others had offered to supply the plant, and others had written for further particulars. One company, the Gülcher, tendered as follows:—To supply 12 300 candle-power incandescent lamps, fix machinery, and find everything necessary for £360 per annum for three years, and after that £335 per year. If others would take the light the price would be proportionately reduced. Mr. Woodley, of London, had called on the surveyor and the chairman and made an offer to the following effect:—For a guarantee to take 400 lamps of 50 candle-power, or its equivalent, he would agree to supply and keep them lit on an average of five hours per day at ¼d. per hour per lamp, or £1 per night. Two hundred lamps would light the town, Parade, and Shelter at a cost of £365 per year. The surveyor had no doubt that the other 200 lights would be guaranteed by others in the town. Mr. Day said they spent over £365 a year now for gas. The Clerk: £426 last year, and £2 per week for lamp lighting. The Surveyor said that at the end of the first year the town would have to renew the lamps, which would cost 4s. each, or a total of £40. In regard to the Shelter only Mr. Woodley said it was a very small affair, and it would therefore become more expensive. To light that alone he would require £100 per year. Mr. Lake and others thought a mistake had been made, and that the lighting could not be done so cheaply. The Chairman thought there was no mistake at all. If the board had their new reservoir finished a 1-inch pipe would give sufficient power to drive the machinery to light the Shelter. The Surveyor said Mr. Woodley told him he could compete in London with gas companies where the gas was 2s. 2d. per 1,000, and he felt sure he could compete in a small place where it was 4s. per 1,000. The matter was referred to a special meeting to be further considered.

Buckingham and the Electric Light.—At the last monthly meeting of the Buckingham Town Council the following resolution was unanimously adopted :—"Resolved, that the local authority of this borough grant to the proposed Buckingham Electric Light and Power Company, Limited, after being registered, consent to their carrying wires for supplying electricity, either overhead or underground, along or across the streets of the said borough for any public or private purpose, according to the plan now produced so far as overhead wires are concerned, but not to the exclusion of the said authority or any other company or companies, subject to such overhead wires being carried at least 30 feet above the roadways, or being properly secured against accident, and on all damage by the proposed company to any public or private property or the streets or roads in carrying such wires over or under such property or the streets or roads being made good by the proposed company to the satisfaction of the Street Committee or the Borough Surveyor, and also subject to the said proposed company obtaining the necessary licence from the Board of Trade."

Electric Light in Pittsburg.—The "United States Company" has obtained the contract for the electric lighting of the Pittsburgh Town Hall. The installation will consist of 3,000 incandescence lamps; the dynamos are four of 800 lamps and one of 400 lamps; the motive power will be supplied by three Armington-Sims engines of 135 H.P.

Theatre Lighting.—Important alterations are to be made in the installation at the Théâtre de la Monnaie, at Brussels, which has not been found quite satisfactory. The municipality will be concerned in the matter, the electric lighting section being placed in the hands of their engineer, M. Wybauw. The long distance system will be employed, the central station being at the town gas works. Owing, however, to the number of rival systems of transformers in the market it will probably be some time before a final selection is made.

An injunction has been obtained by the tenants of premises adjoining La Comedia Theatre at Madrid on account of the noise. *Industries*' correspondent thinks there is an opening in Madrid for a large central electric light station, which ought to be profitable, as the price of gas is 9s. per 1,000. The owners of the theatre will probably appeal against the decision, on the plea that they are merely complying with the order respecting the lighting of theatres; but the installation cannot continue as it is, for there is not sufficient space to manage it properly, and it is certainly very noisy.

The Electric Lighting of the Parks.—The *British Medical Journal* dealing with this subject in its last issue, says: "In connection with the public feeling which has been aroused by the recent outrage in Regent's Park, it may be hoped that official attention will be effectually directed to the question of rescuing the public parks from their present anomalous condition as unlighted and unguarded spaces, which at night are scenes of obstruction, danger, and demoralisation, instead of being areas of light and much-needed recreation. To aid this result it may not be inopportune to republish the following extract from the address delivered in 1884 by Mr. Ernest Hart before the Society of Arts on the International Health Exhibition, its Influence and Possible Sequels :—'I have inquired from a good source what would be the cost of lighting Hyde Park by the electric light; and I am not speaking without data when I say that I believe that Hyde Park could be adequately lighted with the electric light, so that it might add to the resources of health and enjoyment for the teeming population surrounding it, at an annual expenditure of about £5,000. Nor is it likely that the example once set, it would end here. Our Eastern population have a right to the enjoyment of their parks in the evenings that could be conceded to the West.'"

Electric Lights in Omnibuses.—Mr. James Willing, jun., has recently patented a contrivance which enables the electric lamp to be used in road cars, omnibuses, and trams. The electricity required is stored in a small box which can easily be disposed of on the outside of an omnibus out of sight. A flexible wire connects this box with the lamp, which is so constructed that the shifting of the lamp itself a few inches in the grooves of its fittings connects with the current, and thus produces the light. A reverse motion extinguishes it. The storage batteries are charged for two days. This simple contrivance is said to have been used with satisfactory results upon some fifty omnibuses and road cars in London.

Electric Light in New York.—The Municipal Council of New York has received the following tenders for the electric lighting of the streets in the city :—

Company.	No. of lamps.	Price per lamp per night. Francs.
Brush	441	1·55
United States	411	1·55
East River	493	1·55
Mount Morris	22	0·87½
	79	1·15
	31	1·40
	52	1·45
	129	1·60
	23	2·00
North New York ...	238	1·50
	153	1·45
Harlem Electric Light...	36	1·30
	186	1·40
	146	1·45
	55	1·55
	19	2·50
	7	3·00
Ball	90	1·40

Exeter and the Electric Light.—At last week's meeting of the Exeter Town Council the Navigation Committee presented a letter which the surveyor had written to the Town Clerk, in which he stated that the canal foreman had reported that the proposed work on the western bank of the River Exe for drawing water for power above Trew's Weir by the electric lighting committee had been begun. He did not suppose that the bank would be cut and begun until the leat and machinery were placed, but as the matter was of great importance to the canal some knowledge of what was proposed to be done should be in possession of the council. The committee recommended that the Town Clerk forthwith take counsel's opinion upon the general question of the council's rights in connection with the river at the point in question, and that notice be at once given to the electric lighting company that the council objected to any interference with the waters of the river without their express consent and approval being first obtained. The Town Clerk read a letter from Mr. H. W. Michelmore, secretary to the Exeter Electric Lighting Company, saying that the company had no intention of interfering with the canal, nor any desire to act in hostility towards the council or infringe their rights. He suggested a friendly conference between the directors of the company and a committee of the council. In the meantime the company would stop the works. Mr. Townsend moved the adoption of the report of the committee, and hoped that the suggested conference would be arranged. Mr. Dunn, seconding, said he did not think a conference between a committee of this council and a body of gentlemen like the directors of this company could settle a point of law. Mr. Tremlett moved, as an amendment to the adoption of the report, that the invitation to a conference be accepted. Mr. Wilson seconded. After discussion it was decided to adopt the recommendation of the committee to obtain counsel's opinion, with the omission of the word "forthwith." Afterwards a resolution was carried, at the instance of Mr. Townsend, that a conference with the company be held, but that prior to its being held the company should be asked to state in writing what works it was intended to carry out.

Domestic Lighting.—The introduction of electric lighting into private houses in London is proceeding apace, says the *Manchester Guardian*. Lord Wantage's new installation in Carlton Gardens, which shows off the tapestries in the hall and the beautiful pictures in the drawing rooms to great advantage, was seen by his friends for the first time at a party the other evening; and Mrs. Cyril Flower's recent crowded reception at Surrey House was made brilliant (except for a brief period of accidental but total obscuration) by the same agency. We are assured that more amusement than inconvenience was caused by the temporary extinction of the light; perhaps a few repetitions of alternate light and darkness might change the aristocratic amusement into something approaching mild resentment.

Theatre Lighting.—Some theatre proprietors in Madrid, whose arrangements are not sufficiently far advanced to allow of their installing the electric light by next September, as required by the present regulations, have agreed to petition the Government for an extension of time. In the meantime two of their number have been deputed to visit France and England, to inquire into the best system to be adopted.

Electric Lighting in Madrid.—The Gülcher Company is going to light part of Madrid, the installation being one of about 4,000 lights.

Electric Lighting in Ipswich.—The electric light installation at Messrs. G. Mason & Co.'s Oil Mills, the work of Messrs. Paris and Scott, of Norwich, has just been inspected and passed by Mr. Musgrave Heaphy, C.E. The plant consists of a Tangye engine of 10 horse-power, fitted with a Turner-Hartnell governor. This engine drives one of Messrs. Paris and Scott's new patent "C" type dynamos, which generates the electric current carried direct to each building by six cables; the seventh cable charges a set of 13 accumulators. There are distributed about the works three lamps of 200 candle-power each, 47 of 16 candle-power, and 13 of 8 candle-power.

Portable Electric Light Plant.—Messrs. Siemens and Halske have constructed at Vienna an electric light car containing boiler, steam dynamo, and accessories, which weighs without coal or water 3 tons 8 cwt. Steam is supplied by a vertical boiler of 90 square feet heating surface. The dynamo is direct driven by an inverted engine developing 9 H.P. It has a Gramme armature, with internal poles. The output is 90 ampères at 55 volts pressure, and the makers claim that they obtain one electrical H.P. with an expenditure of 44 lbs. of feed water per hour.

Kensington and the Electric Light.—At the last meeting of the Kensington Vestry the Works Committee reported having again considered the letter from the solicitors to the Kensington Court Electric Lighting Company, requesting the permission of the Vestry to the laying of about 100 yards of underground cable in Montpelier Street, and that they adhered to their recommendation that such request be granted. After some discussion, the report was adopted.

Edinburgh Electric Lighting.—At the meeting of the Edinburgh Town Council, on Tuesday, the Town Clerk read a letter from the secretary of the Anglo-American Brush Electric Lighting Corporation, with regard to the conditions imposed by the Town Council for permission to lay their conductors under the street for the electric lighting of Prince's Street. The company thought that to enable them to go to the expense of laying conductors in the streets the contract should be for a period of not less than seven years, and representing that the rate proposed was too high, especially in view of the fact that they might not have a full demand for the first few years, and suggesting that the price should be reduced to 6d. per yard, or adjusted to a sliding scale. The matter was remitted to the Streets and Buildings Committee.

Electric Lighting Act Amendment.—The Electric Lighting Act Amendment Bill was read a third time in the House of Commons on Thursday last week. The Lords considered the Commons amendments on Monday, and agreed to them.

Ship Lighting.—The Union Steamship Company's R.M.S. *Tartar* has just had her engines converted to the triple expansion system. The work has been executed by Messrs. T. Richardson and Sons, of Hartlepool. Whilst the alteration of the *Tartar's* engines was proceeding, advantage was taken of the opportunity to fit her throughout with a complete installation of electric lighting. All dining saloons, cabins, smoking rooms, music rooms, &c., are now lighted in this manner. The work was carried out by Messrs. Siemens Brothers, & Co.

The Telephone in Boston.—We read that the telephone company in Boston has 4½ miles of conduits, containing 785 miles of wire, and with room for over 6,000 miles more.

United Telephone Company.—Says the *Financial News*: The Metropolitan Members are unanimously of opinion that the United Telephone Company should not get the Act they have applied for. The company is evidently even more unpopular than we thought. Not one member out of 70 was willing to say a good word for it. On the other hand the shares are firm. Evidently the shareholders think that the less power the board has, the less harm it can do.

Copenhagen Telephone System.—There are three types of cable employed in the Copenhagen telephone system. The overhead cables are composed of 26 conductors, each of 0·8 mm. diameter, sufficiently insulated, and protected by a sheathing of 19 steel wires. The cable is then covered with some incombustible material. The underground cables have 27 conductors, those for short distances being 0·8 mm. diameter, and for long distances 1 mm. diameter, and well insulated. The insulating material is surrounded with a covering of tin and three bare copper wires are wound round it. The external protection is a double coat of lead covered with an asphalte composition. The insulation varies from 500 to 1,500 megohms per kilometre, and the electro-static capacity from 0·19 to 0·13 microfarads. The submarine cables have 30 wires insulated with gutta-percha and protected with a sheathing of steel wires. The total length of the three types of cable amounts to 28 kilometres.

Telegraph and Telephones.—A contest of an interesting kind took place last month between the office of the *New York Sun* and that of the *Boston Herald*. The object was to see by which means, the telegraph or the telephone, messages could be the more rapidly and accurately transmitted. The contest lasted 10 minutes, and the telegraph was held to have had the best of it, as the copy turned out by the receiver on that instrument was "delivered all right and in shape for the printers," while the telephonic message was "delivered in abbreviations that are not comprehensible to printers."

Free Telegraphy.—Upon the day of the inauguration of the railway between Guadalajara and Mexico, the telegraph line between these towns was placed at the service of the public, no charge whatever being made for the transmission of messages up to noon; no less than 1,236 telegrams were sent. The "free luncher" evidently came to the fore upon this occasion.

Projected Australasian Cable.—A Philadelphia telegram states that the British steamer *Egeria* has been selected to serve in a survey for the best route for mail steamers, and also for a submarine cable between British Columbia and Australia, viâ the Fiji Islands and the northern coast of New Zealand. The route surveyed will be 200 miles wide.

Indian Telegraph Rates.—A Bombay telegram states that owing to the fall in exchange, the rates for foreign telegrams to Europe will be increased by three annas a word on July 1st.

Indo-Australian Cable.—Messrs. C. and E. Millar's proposal to construct a cable to connect the colony with India has been finally accepted by the Legislative Council of Western Australia, with certain modifications. The House conceded them the sole right to use the shore between North-West Cape and Derby for 21 years, provided the work of laying the cable is completed in two and a-half years and the contract signed within six months. A deposit of £10,000 is to be paid on signing the contract, and the Government is to convey cable messages to the other colonies over its land lines at the rates in force from time to time, with the addition of a penny a word, the charge, however, in no case to exceed 3d. a word. The Government and press messages are to be taken at reduced rates, to be mutually agreed upon. In the debate it was pointed out that the maximum that could be charged should be 2s. 6d. for 10 words, while the Port Darwin line charged 7s. This would have the effect of drawing business through Western Australia. The Government stated that until there was a necessity for a change the maximum rate would at present be adhered to, namely, a penny a word, plus a penny a word for cables.

Proposed New Telegraph Cable in the Hebrides.—A movement for the extension of the telegraph system in the Outer Hebrides in order to facilitate the increasing work in the telegraphic department of the post office is, we understand, likely soon to be brought under the notice of the postal authorities. To accomplish this it is proposed that Lochmaddy, in Uist, and Dunvegan, in Skye, should be connected by a cable, the distance across the Minch between these two places being rather less than 24 miles, thus making a direct communication between the southern portion of the Long Island and the mainland.

Execution by Electricity.—Dr. B. W. Richardson contends that the method of execution by electricity is not certain, and that in exceptional cases the shock will only stun. In experiments conducted by himself, he found that a sheep which was supposed to have been killed by the electric discharge recovered in a few minutes, and had to be despatched by the ordinary method. In another case, a large dog which was supposed to be dead was operated upon, and made a safe and easy recovery. He therefore urges the authorities of New York, where the electrical method is to come into operation in January next, to make certain that death takes place by holding a post-mortem examination of condemned criminals, so that they may not be buried alive.

Society of Arts Conversazione.—The society's annual *conversazione* took place on Wednesday evening at the South Kensington Museum, the company, to the number of about two thousand, being received by Sir Douglas Galton, K.C.B., D.C.L., F.R.S. (Chairman), and other members of the council of the society. The entertainment provided included promenade concerts by the band of the Royal Artillery and the Blue Hungarian Band; a vocal and instrumental concert, and a performance of the Royal Criterion Handbell Ringers and Glee Singers. The electric lighting of the galleries contributed to the brilliancy of the scene and to the comfort of the visitors.

Electrician Wanted.—The Glasgow Corporation is advertising for applications from "electric lighting engineers not connected with any system of electric lighting, or with makers or sellers of electric lighting apparatus," for performing the duty of superintending the fitting up, under contract, and the testing of the electric lighting apparatus and fittings in the new Municipal Buildings.

Westinghouse v. Edison.—The announcements which have appeared in the American press, stating that the Westinghouse Electric Company had made arrangements to amalgamate with the Edison interests in America, is contradicted by the Westinghouse Company.

Soap Bubbles.—Mr. C. V. Boys's interesting magnetic and electric experiments with soap bubbles, and his wonderful manipulative skill, says *Nature*, remind old *habitués* of the Royal Institution how exquisitely Faraday handled soap bubbles blown with oxygen to illustrate the magnetic character of that gas. Mr. Boys blows one bubble inside another, and, on bringing the two into an electric field, the perfect indifference of the inner one to any change of potential clearly shows that electrification is confined to the absolute surfaces of a conductor, and that it is not felt at any depth within it, however small.

New Electrical Torpedo.—A series of experiments designed to test the capabilities of Mr. Nordenfelt's electrical torpedo took place last Friday afternoon off Erith, under the direction of the inventor. The Nordenfelt torpedo differs from the varieties hitherto employed chiefly in respect to the manner in which it is controlled from the base of operation. Its length is 35 feet, its maximum charge 500 lbs., and its weight 780 lbs. The torpedo travels at the rate of some 14½ knots an hour, and is capable of carrying 4,000 yards of 3-cored cable. The operations are conducted electrically by means of this cable, one end of which is attached either to the shore—as was the case in the experiments last week—or to the vessel whence the torpedo is despatched. Abundant proof was afforded that the machine may be entirely controlled, in respect both to speed and direction, by Mr. Nordenfelt's system, the experiments being generally pronounced to be thoroughly satisfactory. We should much like to know what resemblance the Nordenfelt system of torpedo propulsion bears to that devised by the late Richard Werdermann some 12 or 15 years ago.

Society of Telegraph-Engineers and Electricians.—Invitations have been issued by the President for a *conversazione* on July 10th.

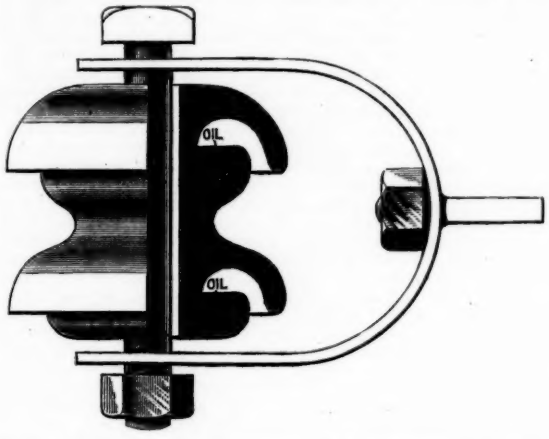
Loeb Chemical Electric Lighting Company, Limited.—A dividend of 5s. in the pound, less a proportion of the excess beyond £50 of Messrs. Hatchett, Jones & Co.'s taxed costs, has been paid by the liquidator of this company.

Electrical Motive Power in New York.—Says Mr. Mansfield in a recent paper:—To operate the elevated roads of New York would require 12,000 horse-power of electrical motors; and allowing 50 per cent. loss between the engines and the cars, 24,000 horse-power would be required, which could be divided up amongst a number of stations of 5,000 horse-power capacity each. Electric motor men claim that from 30 to 40 per cent. can be saved in the cost between steam and electricity.

The Seel Incandescent Lamp.—It is announced that the Berlin Glow Lamp Company contemplates establishing lamp works in England, for the manufacture of this new lamp. In the meantime they have opened a London agency for the sale of same, which are supplied in all voltages and candle-powers up to 100 C.P. One of the novelties made by this company is a double filament lamp of 50 volts 30 C.P., or 100 volts 40 C.P., specially suited for alternating current systems, and one of the advantages claimed for this new lamp is that when one filament breaks the light is simply reduced to one-half its original candle-power, thus reducing the expenditure for lamps for incandescent lighting.

The Royal Society.—At the meeting yesterday afternoon, a paper was to have been read by Dr. Waller "On the Electromotive Changes connected with the Beat of the Mammalian Heart, and of the Human Heart in particular."

Oil Insulator.—Mr. F. Higgins, of the Exchange Telegraph Company, has sent for our inspection an example of an oil insulator for shackles, which he has designed for use on his company's lines, and which he thinks might perhaps be of use for the insulation of



overhouse electric light wires. We first imagined that Mr. Higgins had been looking at one of Johnson and Phillips's insulators until he suddenly saw double, but upon closer inspection we noticed that it was stamped as the latter firm's patent.

Industrial Applications of Electricity.—The Berlin company "Berliner Electrizitaetswerke" has published the following schedule of tariffs for the use of electromotors :—

Employment of motor.	Horse-power.	Tariff per month in marks.	Cost per hour in pfennigs.
Sewing machines, medical apparatus, &c.	= 1/15	1.0	3.8
Coffee and rice mills, grindstones, ventilators, &c.	= 1/4	3.0	11.3
Machines for wood work, ventilators for large halls, pumps, small ice machines, 3 to 5 small printing presses	= 1/2	5.50	20.7
Borers, circular saws, &c. ...	= 1	10.0	38
Cranes, elevators, lifts, large printing and lithographic presses, small workshops, &c....	= 2	19.0	72
Elevators, tramways, &c. ...	= 3	28.0	105
	= 5	45.0	170
Transmission, machinery, electric railways, factories, cranes ...	= 8	70.0	264
	= 12	105.0	396

NOTE.—The mark of 100 pfennigs can be roughly taken as equal to one shilling.

Explosions in Conduits.—In Chicago there have lately occurred a number of explosions in the underground conduits. These accidents are due, it is said, to leakage from the gas pipes, which appear to be very badly jointed.

The D'Humy Cabinet Battery.—A correspondent writes us as follows :—"The suggestion conveyed in your leaderette of June 15th on the D'Humy cabinet battery has been, I believe, already anticipated, as it is currently reported that a gentleman of wide-world celebrity in the cause of sanitation has joined the 'D'Humy Cabinet Battery' Syndicate. This would appear to be a most valuable addition to the strength of the board, which is to be congratulated upon acquiring the services of a gentleman who possesses the practical knowledge necessary to successfully develop the 'water' and the 'cabinet' batteries, a combination which, it is needless to remark, promises to be of great domestic utility."

To those whom it may Concern.—We quote the following remarks, which are unfortunately only too generally applicable, from a well-known American authority :—"The strong points of the average executive committee of an electrical corporation are an innocence of electrical knowledge, an inability to distinguish between the words 'economy' and 'parsimony,' and an indisposition to see that a dollar properly expended to-day means a good many saved throughout the year."

Electric Tramways in Australia.—Messrs. Booth, Ellson & Co., electrical engineers, of Queen Street, Melbourne, have made tenders to the Sandhurst and Eaglehawk Borough Councils for the formation of electrical tramways on behalf of a syndicate of Melbourne and Sandhurst residents. The capital necessary for carrying out the scheme is £100,000. The proposal is in the first place to form a line 4½ miles long through Sandhurst to Eaglehawk. The portion of the line through the city of Sandhurst is to be a double one, and the cars have to be running within two years. A second line is to proceed from Kangaroo Flat through Sandhurst to White Hills, a distance of seven miles and a half, in three years' time. It is agreed to pay the joint councils £100 as an annual subsidy for conceding the sole right to use the streets of Sandhurst and Eaglehawk for tramway purposes for 30 years, and should the annual profits available for dividends exceed 8 per cent. per annum on the called up capital, one-third is to be paid to the councils. An alternative proposition is that the company should pay a subsidy of £100 per annum until the lines are in running order, and then the sum of £500 annually ; and should the profits exceed 10 per cent., one-quarter of the excess will be paid to the councils. It is proposed to employ accumulators for the propulsion of the cars. It is the intention of Messrs. Booth, Ellson & Co., to make an offer to the Sydney corporation to introduce the electrical system into that city.

Long Distance Distribution.—The Westinghouse Electric Company is engaged in making experiments to obtain data regarding the long distance distribution of electric lighting on their system. A number of lights were put up at a distance of four miles from the dynamo, and as a result of their trial several changes were found necessary in the methods used. The firm is now erecting two plants, one at Bernadino and the other at Riverside, California.

Electrical Launches.—Messrs. Immisch and Co. have for some months past been making a series of experiments in order to place before the public an electric launch, and have established a charging station on the Thames, having on board a very powerful engine and dynamo, by which the launches will be charged by coming alongside, and after which the boats will be enabled to run from between 10 to 15 hours consecutively, without noise or smoke, and the christening and trial trip of the first of these launches took place on Saturday week.

Telegraphic Enterprise.—We read that a very novel telegraph system exists in the State of Michigan. It appears that some years ago two farmers constructed an overhead line between their respective farms. Later on other farms were connected up, and communication established with a neighbouring village. About seven years ago an association was formed, composed of the farmers interested in the scheme, and of some of the village tradespeople, and the offices of several newspapers, some post offices and railway stations, and a central telephone office were by degrees connected with the system. Each farmer repairs and maintains his own section, and is himself the telegraphist, Morse instruments being employed. The association has always been in a very prosperous condition and to-day owns some 65 miles of line connecting 90 stations.

NEW COMPANY REGISTERED.

J. and J. Charlesworth, Limited.—Capital £500,000 in £100 shares. Objects:—To purchase the assets and goodwill of Messrs. J. and J. Charlesworth, of Lofthouse, near Wakefield, colliery owners. To carry on at Lofthouse and elsewhere in the county of York the business of an electric light company, and of electricians and mechanical engineers. Signatories (with one share each): *A. H. Charlesworth, Chapelthorpe; *J. B. Charlesworth, Mrs. E. B. Charlesworth, *Joseph Charlesworth, of Wakefield; *C. E. Charlesworth, Mrs. F. Charlesworth, of Doncaster; Mrs. E. Charlesworth, Lofthouse Park, Wakefield. Director's qualification, £10,000 each in stocks or shares of the company. The first directors are the signatories denoted by an asterisk; remuneration £2,000 per annum. Registered 14th inst. by Mr. C. A. Wright, as agent for Messrs. Brown, Wilkin and Scott, of Wakefield.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Schmidt Douglas Electric Company, Limited—The annual return of this company, made up to the 31st ult., was filed on the 15th inst. The nominal capital is £50,000 in £10 shares. 1,131 shares are taken up, 350 being considered as fully paid. Upon 670 shares £7 per share has been called up, and £10 per share upon 111 shares. The total calls paid amount to £5,775, and unpaid to £25.

Oriental Telephone Company, Limited.—The annual return of this company, made up to the 8th inst., was filed on the 15th inst. The nominal capital is £300,000 divided into 225,000 ordinary and 75,000 vendors' shares of £1 each, the latter being considered as fully paid up. 223,242 ordinary shares have been allotted, and upon 220,000 shares 11s. per share has been called up, and the full amount is considered as paid upon the remaining 3,242 ordinary shares. The calls paid amount to £120,957 10s. 10d., and unpaid to £42 9s. 2d.

Electrical Automatic Delivery Box Company, Limited.—The statutory return of this company, made up to the 7th inst., was filed on the 14th inst. The nominal capital is £60,000 in £1 shares. 13,970 shares have been allotted, 4,000 of which are considered as fully paid. Upon 9,970 shares 15s. per share has been called up, the calls paid amounting to £4,434 12s., leaving £3,042 18s. unpaid. Registered office, 45, Eastcheap.

Charles L. Baker & Co., Limited.—An agreement, dated 19th November, 1887, and filed on the 7th inst., provides for the purchase by the company of the business carried on by Charles L. Baker & Co., at the Cornbrook Telegraph Works, but more recently at Worsley Street, Chester Road, Hulme. The purchase consideration is £4,913 cash and £10,000 in fully paid deferred shares of £5 each. Registered office, 2, Clarence Buildings, Booth Street, Manchester.

Willans and Robinson, Limited (mechanical and electrical engineers).—The statutory return of this company made up to the 9th ult. was filed on the 16th ult. The nominal capital is £200,000 in £50 shares. 1,120 shares have been taken, of which 980 are considered as fully paid. Upon 140 shares the full amount has been called and paid. Registered office, The Ferry Works, Thames Ditton.

CITY NOTES, REPORTS, MEETINGS, &c.

Maxim-Weston Electric Company, Limited.

A MEETING of the shareholders of this company, convened by the members of the committee of investigation appointed some weeks ago, was held at the Cannon Street Hotel on Friday last week. Mr. Henry A. Grieg was voted to the chair.

The Chairman said they were met together to do, he hoped, a little practical business. Explaining the reasons for calling the meeting, he said to put down in print all they had to say would not be an advantageous thing for a trading company, and it had been thought better for the committee to meet the shareholders face to face. The circumstances in which they found themselves were somewhat peculiar. At the general meeting they passed a report and balance-sheet, and then adjourned. Part of the proceedings of that day ought to have been the election of directors, those retiring being Mr. Hugh Watt and Mr. Swaby. At the adjourned meeting that day four weeks a great deal of feeling was shown, and the two directors were not re-elected; but if not re-elected at the annual meeting they stood, under the articles, as members of the board until the following year. Mr. Watt, therefore, remainded a director, as did also Mr. Swaby, who placed his resignation in the hands of the shareholders, who, however, did not accept it. Legally, therefore, Mr. Watt and Mr. Swaby remained on the board, although Mr. Swaby had since been warned off the premises. Mr. Swaby held 2,000 shares, but had not paid the 5s. per share call on them; and Mr. Watt, just before the meeting was held, paid the unpaid amount, thus relieving Mr. Swaby of his liability. But Mr. Swaby still held 400 shares in the company, which were a sufficient qualification according to the articles of association. Now, although he was not there to whitewash anybody, he thought it only fair to Mr. Swaby to say he had given the committee a 'great deal of valuable information. Mr. Swaby subscribed for 4,000 shares, intending to place 2,000 among the public; but the company was not doing a great deal of business, and he was saddled with those shares; but Mr. Watt relieved him, and his liability ceased. After Mr. Swaby made "a clean breast of it" at the meeting he was ordered off the premises; but he still was a director, and Mr. Watt was at his wits' ends how to prevent him taking his seat. His law was always rather shaky, and he arrived at the conclusion that if he cancelled Mr. Swaby's shares he would no longer be a director, and he did so cancel them, because he once owed the company 5s. per share. It was one of the funniest things he (the chairman) ever heard of; but it was done, and Mr. Swaby was ordered off the premises. Then came the shareholders' meeting, when the committee of five of the largest shareholders presented their report, and then the very painful meeting called by Mr. Watt, who thought it necessary to have a criminal lawyer to support him, and who gave the opinion as to the previous meeting not being legal. Mr. Watt then wrote to Mr. Swaby stating that he had cancelled the cancellation and restored him to the board. Mr. Swaby went to the board again as a director, but when Mr. Watt suggested they had better strengthen the board and invited him to nominate a director, Mr. Swaby said they ought to consult the committee appointed, to which Mr. Watt replied, "I have nothing to do with that." Mr. Swaby, seeing he would be raising a difficulty again with the committee, left the board meeting, and shortly afterwards received another letter from Mr. Watt saying the shares were again cancelled. It was one of the funniest things that could happen, but it had happened in the City of London. He regretted to have to mention Mr. Watt's name so much, but it was because Mr. Watt had made himself practically the company. The 16 of the largest shareholders were nonentities. Mr. Howell never was elected at a legitimate meeting, and Mr. Swaby was not allowed to take his seat. The 16 largest shareholders were undivided in opinion, except that one of them would take no action in the matter one way or the other, only desiring peace. The committee also wished if possible to see peace, but they thought the practical thing to do was to ask the shareholders to choose five independent directors to look into the affairs of the company. Mr. Watt was the autocrat, not of the breakfast table, but of the board table; but if the shareholders thought him of such excessive value that it would be impossible to get on without him—well and good. The committee, however, recommended the appointment of five gentlemen, independent of any interest in the Watt dynamo patent, but interested only in the Maxim-Weston, which he thought shone as brightly as ever. They considered it was impossible for Mr. Watt to serve two masters.

Mr. Jackson remarked that the shareholders ought to be perfectly satisfied as to the legality of their present action, and inquired if the course recommended was clearly a legal one?

The Chairman said it was in accordance with the articles of association, and he had taken the counsel of his own solicitor all through. They must have signatures representing 62,400 shares to enable them to call a meeting for the election of directors, and it was for the purpose of obtaining these that this meeting was called.

Mr. John Newton, as the one who suggested this meeting, explained the exact object in view. The 16 largest shareholders might, he said, have called the meeting, but it would have had the appearance of a hole-and-corner affair. They had no faith in Mr. Watt being in a position to buy, on behalf of the company, something of which he was the proprietor, although that was what he seemed prepared to undertake. He had lost all faith in any company and in any subject with which Mr. Watt might be connected. He would give a reason. At the last meeting Mr. Watt told them from the chair—he (Mr. Newton) said it deliberately and calmly, in order that Mr. Watt's secretary, who was present taking notes, might report to him what he said—that he had had some sort of communication with Mr. Brown, a retiring director, which communication empowered him in some sort of way to elect Mr. Howell. It was, he said, with the concurrence of Mr. Brown that Mr. Howell was elected. He believed this until he saw under the handwriting of Mr. Brown a letter addressed to Mr. Swaby, who was equally astonished to hear the information. Mr. Newton proceeded to read the letter, dated May 4th, in which Mr. Brown

said that since he had retired from the board he had held no communication with any officials or anyone connected with the company respecting its proceedings, and had never been consulted by anyone connected with it. The resolutions to be submitted at the meeting it was proposed to call were, first: "That, considering the peculiar position of the board as at present constituted, it is desirable that at least five independent shareholders shall be elected as directors;" and, secondly, "That the following gentlemen be elected directors to strengthen the board"—names to be added.

Mr. Newton said, in reply to a question, the committee disputed that the dynamo patent belonged to Mr. Watt, and claimed that it belonged to the company; but it was not desirable to go into that matter now.

A Shareholder: What provision is made under the articles as to the number of directors?

The Chairman: They provide for seven, with a remuneration of £500 a year among them.

Mr. Hildyard: Mr. Watt receives £1,200 as chairman, the arrangement being subject to six months' notice.

Mr. Klenck said the result of the committee's investigation was such that they believed that at the present time the company's interests were not properly looked after.

After some further discussion, the following gentlemen were selected for the directorship, and the shareholders proceeded to sign the requisition for a meeting to elect them:—Messrs. Klenck, G. H. Hildyard, Jno. Marks, W. D. Harvest, and Couchman. It was stated that Messrs. Hildyard and Couchman would retire as soon as two suitable electrical experts could be found to take their places.

The proceedings then terminated.

Schanschieff Electric Light and Power Company, Limited.

A GENERAL meeting of this company was held at the offices, 44, Basinghall Street, E.C., on Friday, the 15th inst., when Lord Cathcart, chairman of the company, presided.

Mr. T. G. Wells, the Secretary, having read the notice convening the meeting,

The Chairman rose to propose "That this company be wound up voluntarily, under the provisions of the Companies' Acts, 1862 and 1867." As the reason for the course adopted by the directors in recommending the winding up of the company, the chairman alluded to the litigation pending respecting the validity of the Schanschieff patents. They had very little doubt as to what the issue of the litigation would be, but thought it inadvisable to tie up the shareholders' money for an indefinite period, and had therefore applied to the vendor syndicate to rescind the sale contract. He personally held the highest opinion both of Mr. Schanschieff and of his battery, and to show his faith in the invention intended to subscribe a further sum towards the capital of the syndicate. The syndicate had met them very fairly, and had agreed to their proposition and to take upon themselves all responsibility with regard to the patent suit. It was most likely therefore that the shareholders would have returned to them the whole of their money, but it was possible that there might be some small deductions. The opinion of Mr. Cozens Hardy had been taken upon the position of the company, and he had advised that they could not commence operations whilst the suit was pending. In response to questions, the chairman said that when the resuscitation of the syndicate took place, shareholders of this company would be offered the option of taking an interest in the new concern to the extent of £10,000. After some conversation of an unimportant character, the motion was seconded and carried unanimously, the chairman announcing that a confirmatory meeting would be held on July 2nd.

Schanschieff Electric Battery Syndicate, Limited.—Creditors of this company are required to send in their claims on or before July 31st to Sigmund Hoffnung, 102, Fore Street; or to Frederick H. Harvey-Samuel, 1, Whittington Avenue, the official liquidators.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended March 31st of 2s. 6d. per share, tax free, payable on July 14th.

The South of England Telephone Company, Limited.—The directors recommend a dividend of ½ per cent. on the ordinary share capital for the year ending April 30th last, placing £500 to a reserve fund and carrying forward £1,115 0s. 8d. The dividends on the preferred shares have already been paid.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 15th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £8,925.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th June are £2,931, as compared with £2,792 in the corresponding period of 1887.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending June 15th amounted to £4,760.

NEW PATENTS—1888.

8401. "Improvements in electric batteries." E. W. CLIFTON and V. ROBINSON. Dated June 8.

8457. "Improvements in telephones." L. MELLETT. Dated June 9. (*Complete.*)

8496. "Improvement in electro coating metals with zinc." J. LEA and H. R. HAMMOND. Dated June 9.

8503. "Improvements in magneto-electric fuses or exploders." E. DUCRETET. Dated June 9.

8525. "Improvements in electric trembling bells." F. L. RAWSON and P. JOLIN. Dated June 11.

8596. "Improvements in automatic telegraphy." J. Y. JOHNSON. (Communicated by E. J. Mallett, United States.) Dated June 12. (*Complete.*)

8611. "An improved form of galvanic belt for medical purposes." W. LAUGHTON. Dated June 12.

8637. "Improvements in electric clocks." A. L. PARCELLE. Dated June 12. (*Complete.*)

8657. "Improvements in dynamo-electric machines." H. BARCROFT. Dated June 13.

8700. "Improvements in and relating to electric batteries." L. M. J. C. C. RENARD. Dated June 13.

8724. "An improved appliance or switch for electrical machines or apparatus." W. SNELGROVE. Dated June 14.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1887.

4220. "Improvements in instruments for measuring electric currents." J. W. KING. Dated March 21. 8d. Claims:—1. In instruments for measuring electric currents the employment of a strip or strips of metal of a shape approximating to those illustrated in the drawings, whereby their shape and disposition ensures promptness and vigour of action, together with direct proportionality of angle of deflection to the current passing, as herein set forth. 2. In instruments for measuring electric currents, the method and means for effecting the vertical alteration of the needle in combination with a second or more set of readings, substantially as set forth and illustrated with reference to the drawings.

4447. "A new or improved apparatus for measuring, indicating, and recording currents of electricity." P. B. ELWELL. Dated March 25. 8d. Consists in the combination in one apparatus of a voltmeter, an ammeter, and an electric meter, and in the construction and arrangement of the various parts or constituents of the combination. The apparatus consists of a high resistance solenoid motor, for indicating the E.M.F., a low resistance solenoid current indicator or ammeter, and of appliances for registering and recording the total current, these appliances being actuated and controlled by the combined operation of the motor and of the ammeter. The claims are 3 in number.

4832. "Improvements in the manufacture and construction of carbon 'plates' or electrodes for use in primary batteries, and for electro-metallurgical, electrolytical, and other electrical purposes." H. LIEPMANN. Dated March 31. 8d. The inventor constructs compound carbon "plates" or electrodes by casting around carbon rods a lead setting or head. The claims are 5 in number.

5140. "Improvements in galvanic batteries." W. H. QUARTERMAN. Dated April 6. 8d. Claims:—1. In a galvanic battery, the method of affixing the zinc electrodes to binding screws on the edge of the outer case, by means of projecting pieces having curved slots, substantially as and for the purpose set forth. 2. In a galvanic battery, the construction of the lid in two or more parallel strips fitted together with grooved and tongued, or rabetted joints, substantially as and for the purposes herein set forth with reference to the drawings. 3. In a galvanic battery, the construction of the lid in one piece, with holes to slip over the carbon terminals and rubber seatings, and substantially as and for the purposes set forth with reference to the drawings.

5186. "Improvements in brush holders for dynamo-electric machines." A. P. TROTTER and W. T. GOOLDEN. Dated April 7. 8d. The adjustment of the brushes is effected by so constructing the holder as to allow of the brush being traversed in a direction perpendicular to the axis of rotation of the commutator, or at any desired degree of obliquity to such axis, the traversing being effected and controlled by the motion of a screw. There is 1 claim.

5193. "Improvements relating to a system of generation and distribution of electricity." G. A. GRINDLE. Dated April 7. 8d. Two metallic conductors constitute the distributing mains, the current is supplied to these at several points by means of transformers, or secondary generators, or dynamos driven by electromotors which are actuated by a high tension current conveyed to them by a separate wire or wires, the said high tension current being supplied to the said transformers, secondary generators, or motors, either on the series or parallel systems, or a combination thereof. The claims are 3 in number.

5210. "Improvements in automatic apparatus for subjecting the person to the action of electric currents." A. SERRAILLIER. Dated April 7. 8d. An upright casing has at its upper part a

shoot through which a coin can be introduced so as to descend on to the end of a lever that is connected to the one terminal of an electrical circuit, including a galvanic battery, the other terminal of which is connected to a second lever situated below the first one, and in such a position that on the first lever being depressed by the introduction of a coin, it makes contact with the second one, and so closes the circuit. This circuit also includes a small electric motor, the motion of which effects the slow rotation of a disc cam, having a drop at one point. The first named lever has a weighted tail that bears upon the surface of the cam which, when the apparatus is at rest, is so placed that the tail of the lever rests on the lowest point of the drop, in which position the other end of the lever is raised, closing the shoot. On depressing this lever by the introduction of a coin and thus starting the motor, the cam is rotated so as to gradually raise the tail of the lever and thus depress its other end, thereby eventually leaving sufficient space between the lever and shoot to allow the coin to drop out. On the completion of the rotation of the cam the tail of the lever again falls on to the drop, and the front end in rising breaks contact with the second lever, which also has a weighted tail that comes in contact with a stop, preventing its further descent. The electric circuit also includes the primary coil of an induction apparatus or Ruhmkorff coil, the secondary coil of which is connected to handles outside the casing, so that on introducing the coin as described, the electrifying apparatus is put in action and continues so until the circuit is again broken by the action of the cam, as above described. The claims are 3 in number.

5862. "Simultaneous driving of a number of clocks by magneto-electricity." W. BLENHEIM. Dated April 22. 8d. A dynamo or magneto-electric generator worked by a falling weight, spring or other contrivance which would effect the same purpose, the armature of which generator is held in a position of rest by an escapement connected with a clock or other timekeeper, which at any required periodical intervals liberates the escapement, thereby allowing the armature to revolve and so generate an electric current. These currents are used by means of other ordinary magnetic apparatus to propel simultaneously a number of other clocks. There are 2 claims.

5958. "Improvements in dynamo-electric and magneto-electric machines." A. M. CLARK. (A communication from abroad by L. MAICHE, of Paris.) Dated April 23. 8d. Claims:—1. A dynamo-electric or magneto-electric machine in which both the field magnets and armature coil are stationary and the current is generated by the motion of an iron core or armature of any suitable form, traversing the armature coil and moving in the magnetic field, as described. 2. The described method of exciting the field electro-magnets of an alternating current machine, which consists in rectifying a portion of the current by means of a voltameter of the kind herein-described, or by means of a series of voltaic cells having an electromotive force equal to that of the machine, the currents in the one direction being absorbed by, and regenerating, the battery, while the currents in the other direction combine with the current of the battery as specified.

6267. "Lock switches for use in electric circuits." A. C. COCKBURN and E. THOMAS. Dated April 29. 8d. Consists in providing a latch, or other locking device, which, when contact has been established in the switch, springs into action, and holds the movable contact piece, or bar, firmly in position, independent of the handle or button, and independent of the pressure or friction of the fixed contact pieces. When the handle or button is turned in the opposite direction, in the course of its movement it causes the latch to be withdrawn, the contact piece or bar being free to move independent of the handle or button, and being actuated by a spring, flies quickly back so soon as the latch is withdrawn, and thus breaks the electric circuit with great certainty and rapidity. There are 2 claims.

6409. "Improvements in dynamo-electric machines and motors." R. E. B. CROMPTON and W. A. KYLE. Dated May 2. 8d. Claims:—1. In a dynamo-electric machine, pole pieces constructed with capability of detachment from the magnets to admit of easy access to the armature without removal of the armature, substantially as described. 2. In a dynamo-electric machine having a drum armature and connectors applied thereto externally of the circumference of the armature.

6590. "An improved magneto-electric cut-out." W. H. SCOTT and E. A. PARIS. Dated May 5. 6d. Claims:—1. In a magnetic cut-out the combination of an electro-magnet with a pivotted adjustable armature normally holding a bridge piece completing the circuit, but which on excess current causing the magnetic force to attract the armature, thereby allows the bridge to drop and the current to be broken, substantially as and for the purposes specified. 2. The combination with such a device of an auxiliary circuit containing a lamp or lamps or resistance, substantially as and for the purposes described. 3. The combination with the device of an auxiliary circuit and a safety fuse, substantially as and for the purposes described.

6621. "An improvement in electro-motors." J. D. F. ANDREWS. Dated May 5. 8d. Claims:—1. In an electro-motor adapted to be worked by alternating currents, connecting the commutator brushes through the field magnet coils to the leads from and to the generator, so that alternations of current produce synchronous alternations of polarity of the field magnets and of the armature coils, substantially as and for the purpose set forth. 2. In an electro-motor operating in the manner referred to in the preceding claim dispensing with cores for the field magnets by arranging the field coils so as to envelope the armature coils, substantially as described.

6681. "Improvements in secondary batteries or electrical accumulators." R. E. B. CROMPTON and J. C. HOWELL. Dated May 6. 8d. Relates to the coupling up and separation of the lead or compound plates used in electric accumulators, and includes insulating rods supported from below, and grids or frames to carry the same, also U-shaped continuous rod and perforated corrugated sheet separators, also the various improved methods of connecting the conductors to the plates themselves and to one another; also to the improved form of the containing cells and providing covers for same. The claims are 8 in number.

CORRESPONDENCE.

The Water Primary Battery.

I read from time to time in your publication remarks of an unjustifiably depreciating character as to an invention which is destined to revolutionise the employment of electric energy as an illuminating medium.

It is beyond all possibility of refutation that the d'Humy primary battery is perfectly constant and reliable in its action, exceedingly economical, requires no skilled attention, and is entirely free from the many and serious objections inseparable from the use of dynamos and motors of every description. It gives off neither noxious fumes nor disagreeable odours. The principal liquid element employed in developing the electric current is water, with acid as the exciting agent, the positive electrodes being iron and the negative ones carbon.

It is due to every inventor, whatever his nationality, to verify the practical results of his researches rather than risk the expression of an *ex parte* opinion regarding them or him.

In the United States of America, as upon the Continent of Europe, the inventions of Mr. D'Humy have been more justly appreciated than in England.

The purchasers of the patents for these inventions in the United States have assured themselves of the exactitude of all the representations made regarding both the "Water Primary Battery," and the "Cabinet Battery," by a series of exhaustive experiments, conducted by experts, who visited this country expressly for the purpose, and the undersigned, who had been delegated from the Continent to the same end, and had the advantage of taking part with these American specialists in their investigations, can, with every confidence, attest to the results obtained.

A portion of these experiments were made at the premises of the Water Primary Battery Company, Limited, which were placed at our absolute and complete control for that purpose, while others were made under circumstances which rendered extraneous intervention utterly impossible; the results in each case being perfectly identical and equally satisfactory.

In justice, therefore, not only to the inventor but to your readers, who are entitled to be kept informed as to *facts*, I rely, Mr. Editor, upon your giving the same publicity to this letter as to the expression of opinion which requires this rectification.

Jno. Thos. Browne, *C.E., of Paris and Madrid.*

June 20th, 1888.

[We do not see that Mr. John Thomas Browne, C.E., of Paris and Madrid, has added one iota to the statements which have previously been made on behalf of this battery. He is careful to avoid figures, and therefore his *facts* will probably be placed in the category of mere assertions. That American and Continental electricians have expressed favourable opinions on the "Water" battery is no fault of ours, it is rather their misfortune, and if capitalists choose to invest their money in a liquid which can be had for the trouble of turning on a tap, that again is their own concern. When Mr. Browne, or anybody else, can give us data compiled in like manner to that which we give this

week respecting a really genuine battery, which is quite without the realms of mystery, we shall be ready to challenge the results, if necessary, or to verify them, if the proprietors of the D'Humy will give us the opportunity.—EDS. ELEC. REV.]

The Management of Accumulators.

My object in addressing you is not to reply to the criticisms you have published upon my little book. I leave the public to form an opinion as to how far they are good or bad; but the writer of the article appears to have had no practical experience with accumulators, and he advises certain things which are now distinctly regarded as likely to destroy a battery in a short space of time. He also makes a series of remarks which are not correct, and likely to influence the public in a wrong direction. In short, most of the subjects are treated in the article under conditions which existed three or four years ago. I must thank the critic for pointing out the error I made regarding the conductive properties of concentrated $H_2 SO_4$, but he might fairly have stated that the figures and the text which follow are perfectly correct, and the slip referred to in no way affects the conclusions. The word lugg (spelt with two g's to avoid confusion with other meanings applied to lug) is universally employed by manufacturers to designate the "tails" of the plates, and the word enters into "specifications." Pasted leaden grids do not become rotten if the cells are kept in good order, but the alloy grids now in use are stronger, and probably will not become rotten for years, even where the cells are badly used. On the other hand, plain lead plates, by frequent reversal to obtain storage in a practical degree, fall to pieces very soon. I have seen batteries a few months old with plates reduced to powder, and still declared not to be fully formed for use. It is due to this: that they have gone out of the market. One type survives—viz., the Howell; but no one appears to have had any experience with it but Mr. Crompton, and perhaps it is too early for him to come to conclusions in regard to durability.

I have experimented upon some 40 types of secondary cells, and had a large correspondence on the various points connected with them with persons living in all parts of the world. I find the general opinion coincides with mine in believing that at present it is only the usual pasted types which are of value on a large scale.

The criticisms on the large number of plates in a cell, and the placing of cells two and two in parallel, in making up the series, are not only wrong, but directly contrary to evidence. The attention required for a battery is directly proportional to the number of plates contained in it, and not the number of cells, and a cell containing 101 plates gives no more trouble to keep in order than one with 5, if both are attended to with the same care. I have used a leaden box with 69 plates for heavy currents, and treated in the roughest way; no difficulties whatever arose. The 31-plate E.P.S. cells can only be managed by two strong men, and more than this number cannot assist in lifting. When the shelves are against the wall I have been told on all sides that the weight was the objection.

Now for cells two and two in parallel I had in my mind all the difficulties suggested in regard to batteries placed in parallel, notwithstanding that many authorities were of the contrary opinion. When my battery was doubled last August I asked the advice of the E.P.S. Company on the subject. The reply was that much experience had not been gained as to whether cells should be placed two and two in parallel or in two series batteries placed parallel. I therefore resolved to try the experiment; I made up a series battery of two and two in parallel. Troubles soon began, for no two cells have exactly the same E.M.F., and the coupled cells discharged one into the other, and with the greatest difficulty could the E.M.F. of the battery be kept up. The engine had to run every day. After three months I foresaw the battery would soon be destroyed, so I wrote my experience to the E.P.S. Company, and their reply was in effect that they had come to the same conclusion, and from that time would no longer couple up as I had done.

The battery was rearranged to two sets, placed parallel, when all the anticipated difficulties were found to be purely imaginary. No resistances or automatic appliances are needed, and out of 7 hours charging both batteries charge alike for $6\frac{1}{2}$ hours, and this is the worst case. Even when charging unequally the difference is trivial, and this very difference soon equalises the two batteries. The discharge is always equal from both sets of cells, unless a cell on one side should be short-circuited; and even this circumstance does not produce the unequal effects which might be supposed. After the alteration the engine was run only twice a week during the shortest days and once a week at other times, so the battery was saved and economy produced by the very action your article condemns. The difficulties at Lloyd's installation, when I visited it, was in a great measure due to so many cells being placed parallel, and I believe the series system is now universally employed.

I strongly urged Messrs. Elwell-Parker to discontinue the use of wood in the building up of the sections, and at last it is going to be done. Properly prepared wood appears to keep well in the acid as regards soundness. Some pieces I have by me have been in strong acid for three years and appear quite sound when cut through; but the disadvantage arises from another reason. After some months it becomes a slight conductor, so that cells in which the sections are held together by wooden bands cannot be left without occasional charging as long as those without them. Ebonite has also this disadvantage, but not to so great an extent. Vulcanite appears to be the best insulating material for placing in the acid solution.

I hope that your article may draw forth the experience of others, although I do not suppose that there will be much difference from the opinions here expressed, because I have received many hundreds of letters on the subject of accumulators from those mostly engaged in making and experimenting with them.

David Salomons.

Broomhill, Tunbridge Wells,
June 18th, 1888.

[We are pleased to publish such a lengthy reply to our criticism on the fourth edition of Sir David Salomons's work. The information here contained is of more value than much which is to be found within the volume in question; but the letter has also an amusing side. The writer of the notice which appeared in our last issue is not devoid of practical experience with secondary batteries; we are inclined, indeed, to the opinion that he has had more than Sir David and all other users put together, and this is where the comicality of the first sentence appears. It seems, however, that so far as actual facts are concerned, Sir David and ourselves are very much of the same mind, and that we only agree to differ in matters of opinion. We shall be glad if the last paragraph contained in Sir David's letter bears fruit.—EDS. ELEC. REV.]

Experiments in Static Electricity with the Incandescent Lamp.

In your last issue you give an account of some very interesting experiments on the above subject made by Mr. Elmer E. E. Emmons. Will you kindly allow me space to confirm most of his statements. Some two years ago in conjunction with my late assistant, Mr. Albert T. Bartlett, now of the Cavendish laboratory, Cambridge, the extraordinary capacity as a condenser of an incandescent lamp was noticed, and some precisely similar experiments to those described by Mr. Emmons made. Our results, however, do not coincide in one or two particulars. Thus we found that when the filament was broken we got the best results. If a

lamp with a damaged filament be grasped in the hand, and the metal connecting the filament with the exterior be held near to the prime conductor of a machine placed in a dark room, a brilliant brush discharge will be observed inside the lamp, caused by the electricity pouring off the end of the carbon and spreading itself over the inner surface of the lamp. If the outside metal is touched with the finger of the other hand while the lamp is thus held, a smart shock will be felt, but if after thus charging the lamp is held between the tops of the fingers so as to reduce the area of the outer coating and then the finger of the other hand applied to the metal, a shock will be felt and the ends of the filament will be observed to glow for a considerable time, thus showing a slow discharge to be taking place. The lamps also show the phenomena known as the residual charge exceedingly well; a 5 candle-power Swan lamp with broken filament giving us no less than four shocks.

There is one statement in your account which I think must be a misprint, because it is virtually contradicted in the preceding paragraph, viz., that which says "the lamp can only be charged by an electrophorus or a running belt if the latter is charged." As a matter of fact, the lamps may be charged by any source of statical electricity, whether it be a machine, excited rod, running belt, or an electrophorus.

We found, what indeed would be expected, that some kinds of lamps gave better results than others, owing no doubt to the varying specific inductive capacity of the different kinds of glass. In fact, the effect is probably explained by the high S.I.C. of the dielectric coupled with, firstly, its thinness; and secondly, the absence of dust and superficial moisture on the interior surface.

After noticing these effects we endeavoured to construct a standard condenser of this type, thinking that with a constant kind of glass, and a stated degree of rarefaction, either of air or some other gas, this might be possible. Circumstances, however, prevented the continuance of these experiments, but it is possible that other experimenters may have obtained results in this direction.

Ernest H. Cook.

Merchant Venturer's School, Bristol.

Testing of Earth Resistances.

I have only just seen the numbers of the 4th and 11th ult. Perhaps, however, you will not consider it too late for a few words more on the subject.

The same idea which Mr. Fletcher broaches had occurred to me, but I rejected it for these reasons.

1. That it entails *three* operations instead of *two*, and
2. That the correctness of the test—where telegraph lines are used—is dependent upon the constancy in point of resistance of *two* lines while *three* tests are being made.

What I claim for my plan is that the constancy of only *one* line is essential. Variations in the second will not affect the correctness of the test.

Then with regard to what Professor Jamieson says as to its being subject to this defect "that one might place or adopt an earth, y, between which and earth, x, there existed comparatively small resistance, whereas x might still have opposed to it a high earth resistance in other directions." It seems to me that this applies with equal force to either method, but with an ever-increasing strength *as the distances between the earth plates are lessened.*

Subject to correction, I submit that the functions of the earth in terminating a circuit are two-fold.

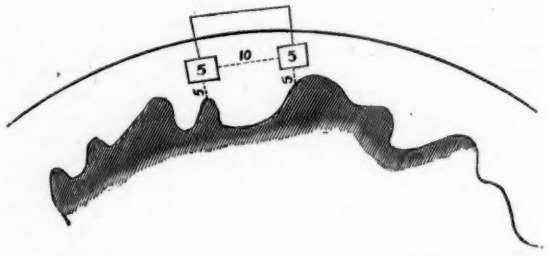
1. There is that property described by Gavarret as follows: "When the extremities of a circuit are connected to the earth, which is an infinitely large conductor, their respective tensions are diffused in all directions without producing any appreciable tension in the earth itself."

Let us call that the earth's power of absorption or diffusion.

2. There is its property as a *conductor*, whereby the soil between the two earth plates serves to complete the circuit in the same way as a return wire.

Of course it is the first of these properties which gives any earth its value, and for the purpose of elucidating which tests are made.

In the following diagram let the outer line represent the surface of the earth, and the inner wavy line that depth where perfect absorption or diffusion takes place. For it may, I think, fairly be held that in the interior of the earth there is, at varying depths, a vein of perfect conducting substances, where perfect absorption or diffusion takes place, and where consequently there is little or no resistance.



Now suppose two earth plates buried outside, and above this vein. Then these earths will offer a certain resistance to diffusion. Call that 5^ω for each plate as in the diagram. Then the *real* sum of these two resistances is evidently 10^ω.

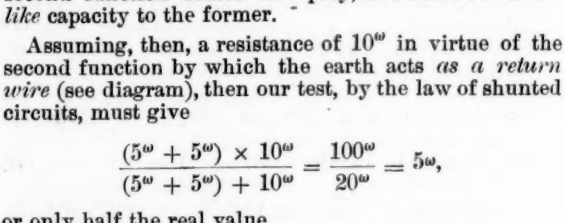
But suppose the plates are near each other. The second function comes into play, and acts in a *shunt-like* capacity to the former.

Assuming, then, a resistance of 10^ω in virtue of the second function by which the earth acts *as a return wire* (see diagram), then our test, by the law of shunted circuits, must give

$$\frac{(5^\omega + 5^\omega) \times 10^\omega}{(5^\omega + 5^\omega) + 10^\omega} = \frac{100^\omega}{20^\omega} = 5\omega,$$

or only half the real value.

Now, assume the distance increased between the plates, and the resistance *between them* in consequence increased to 100^ω, thus



The resistance of the earths we will imagine is still $5 + 5 = 10$.

But the test now will give

$$\frac{(5 + 5) \times 100}{(5 + 5) + 100} = \frac{100}{11} = 9{\cdot}0\dot{9},$$

or very nearly its real value.

The moral, I think, is obvious. Tests of earth resistances are of necessity illusory and misleading when the earths used are adjacent to each other.

Prof. Jamieson says in his "Pocket-Book of Electrical Rules and Tables" (page 182) that they should be at least 10 feet apart.

I ask him now to consider whether that is not altogether too close to ensure correct results being obtained.

J. H. Pomeroy.